DRAFT
ENVIRONMENTAL ASSESSMENT

Management Actions for Immediate Implementation to Reduce the Potential for Extirpation of ‘Ua‘u (Hawaiian Petrel) from Kaua‘i

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Executive Summary

The United States Fish and Wildlife Service (USFWS) is considering management actions for immediate implementation to reduce the potential for the extirpation of the ‘Ua‘u (*Pterodroma sandwichensis,* Hawaiian petrel, HAPE) from Kaua‘i. In accordance with the National Environmental Policy Act (NEPA), this Environmental Assessment (EA) presents a review of the conservation efforts to date to protect the ‘Ua‘u on Kaua‘i, examines a range of alternative management measures, analyzes possible environmental effects of the alternatives, and serves as the basis for a decision by USFWS on which alternative to implement.

The management actions being presented in this EA include:

Alternative A	No-action alternative: continue existing management
Alternative B	Social attraction
Alternative C	Chick translocation combined with social attraction (preferred alternative)

None of the alternatives are expected to cause significant, irreversible impacts to the environment; therefore, the anticipated determination is a Finding of No Significant Impact (FONSI).

Chapter 1. Introduction

1.1. Need for and Purpose of Action

The purpose of the project is to reduce the probability of extirpation of ʻUaʻu from Kauaʻi. The project is needed because preliminary analysis of radar data (from 1993 to present) indicates that the population of ʻUaʻu on Kauaʻi is in serious decline (KESRP unpublished data), and the combined threats facing ʻUaʻu on Kauaʻi mean that extirpation is considered by local seabird experts to be a serious concern.

The information gathered by the Kauaʻi Endangered Seabird Recovery Project (KESRP) indicates that ʻUaʻu populations are declining, as a result of a number of factors including predation at the breeding colonies by introduced mammals and barn owls (*Tyto alba*), collision with power lines, fallout associated with light attraction, and habitat loss. Several known low-elevation sites are at high-risk of colony extirpation with very few birds left. Only a few ʻUaʻu are collected on Kauaʻi each year during the fallout period, but it is not clear whether this is because they are less susceptible than the threatened ʻAʻo (Newell's shearwater, *Puffinus newelli*) to light attraction or because their main breeding areas are less affected by light pollution. Simons (1984) estimated that only 27% of ʻUaʻu chicks survive to adulthood, and because most seabirds are long-lived and have high adult survivorship, low rates of survivorship to adulthood can have large impacts on annual population growth and colony persistence over time.

Like other birds in the order Procellariiformes, ʻUaʻu exhibit strong natal philopatry (tendency to return to birth site to breed) and high nest-site fidelity. These behavioral traits, along with a protracted nesting period and ground nesting habitat, result in great vulnerability to predation by introduced mammals at the breeding colonies (Croxall et al. 2012). This vulnerability has led to the extirpation of many island populations of shearwaters and petrels around the world and made the consequences of stochastic events such as hurricanes, volcanic eruptions, epizootics, or fires at the remaining breeding sites much more significant (Croxall et al. 2012). In addition to protection of existing colonies, the restoration of former colonies or development of new protected colonies through social attraction techniques or translocation is a strategy that is being used as a conservation measure with increasing frequency throughout the world.

Hawaiian petrels were listed as endangered under the Endangered Species Act (ESA) in 1967. ʻUaʻu previously had a widespread prehistoric distribution throughout the Hawaiian Islands, including low elevation coastal plains on Oʻahu and other islands (Olson and James 1982). Today, the breeding population is known from Hawaiʻi island, Maui, Lānaʻi and Kauaʻi, with a small unconfirmed colony on Molokaʻi (Ainley et al. 1997, Penniman et al. 2008), and is estimated to be 6,500-8,300 pairs with an overall population of ~19,000 (Ainley et al. 1997). During the 1990-2000s, the island-wide breeding population on Kauaʻi was estimated as high as 1,600 pairs based on the numbers of birds flying onshore near dusk, primarily along the north shore of the island, and was estimated at 1,200 pairs in 2009 (Pyle 2009).

Known breeding habitat varies. On Maui (Haleakala) and Hawai‘i, ‘Ua‘u breed in open, rocky subalpine habitat at high-elevation. On Lana‘i, Kaua‘i, West Maui, and Moloka‘i, they breed in wet montane forest with dense uluhe fern (VanZant et al. 2014). The presence of ‘Ua‘u in the fossil layer indicates that this species was formerly numerous on the coastal plains of O‘ahu and Kaua‘i. ‘Ua‘u are a K-selected species and are characterized by a long lifespan (up to 35 years), low fecundity (one chick per year), and delayed recruitment (5-6 years; Simons and Hodges 1998). Most pairs show a high degree of nest site fidelity and often remain with the same mate for consecutive years. A single egg is laid in a burrow or on the ground and parental care is equally distributed between the sexes. The incubation and chick-rearing periods are 55 and 110 days, respectively, with some variation in phenology between islands. Chicks are fed an average of 35.6 g per day of regurgitated squid and fish during the last three weeks of the rearing period, and larger amounts, 55.4 – 63.3 g, earlier in the rearing period (Simons 1985). Imprinting on the natal site appears to occur after the chick's first emergence from the burrow, which on Kaua‘i is 15.8±0.94 days before fledging (KESRP unpublished data).

Current monitoring activities related to ‘Ua‘u on Kaua‘i are conducted primarily by the KESRP (formed in 2006 as a project of Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife (DOFAW), administered through the Pacific Cooperative Studies Unit (PCSU) of the University of Hawai‘i). Activities include auditory surveys at night or early morning at specific times of the year when the birds are most active and vocal to try to determine the location of breeding colonies; radar surveys to track the number of birds moving from the sea to inland breeding colonies to try to determine how the population is changing over time; using acoustic recording units (song meters) deployed in remote locations to detect their presence; monitoring known burrows in several remote locations and collecting data on fledging success rates, reasons for failure and site fidelity; banding individual birds to develop a better understanding of individual survival rates; and tracking individual birds at sea using geolocators and satellite tracking tags (KESRP 2015). These monitoring activities are conducted in conjunction with active management (primarily invasive predator control and invasive plant removal) at four of the largest known ‘Ua‘u colonies, on the northwest of the island; predator control methods and techniques are regularly evaluated in terms of effort, expense, and efficacy.

KESRP's efforts demonstrate that identifying individual active burrows is extremely difficult, due to the dense vegetation and steep topography in the areas used by ‘Ua‘u. The difficulty increases as a colony declines in numbers, as the remaining breeding birds spread out over a large area and the intensive searches required to find the burrows can make the remaining birds vulnerable to increased predation pressure. Introduced non-native mammals are a significant threat. Even at the high-elevation colonies receiving predator control, camera monitoring of individual burrows demonstrates the persistence of predators in these remote areas and their impact on fledging success. In 2014 alone, rats visited 95% of the monitored ‘Ua‘u burrows, and 11 different cats were observed (Raine and Banfield 2015a-d). Twenty-seven predation events (of adults and chicks) were documented (13 cat, 14 rat) at these four sites. At unmanaged colonies, predation rates are estimated to be much higher and would include predation by pigs and dogs as well as cats and rats.

Until recent years, Kaua‘i was thought to be free of the small Indian mongoose (*Herpestes* *auropunctatus*). Mongooses are diurnal predators that primarily eat invertebrates and small mammals, as well as plants, birds, reptiles, and amphibians. They are a major threat to any ground-dwelling and ground-nesting bird species, as they are known to eat eggs, young, and adults of endangered Hawaiian birds, various seabirds, and migratory shorebirds (Mitchell et al. 2005, Hays and Conant 2007). Live mongooses were captured on two separate occasions in 2012, in Līhue and Nāwiliwili Port, and credible sightings of mongoose across the island from Kōke‘e to the Mānā Plains have been reported (KISC 2012, 2013). While mongooses have not been observed at known ‘Ua‘u colonies, if this predator were to become more firmly established on Kaua‘i, an immediate and dramatic negative impact on the breeding population would be expected.

In 2014, a 7-acre predator-proof fenced unit was constructed and dogs, cats, rats, and mice were eradicated as part of the Nihoku Ecosystem Restoration Project at Kīlauea Point National Wildlife Refuge (KPNWR). KPNWR is home to one of the largest seabird colonies in the main Hawaiian Islands (MHI), providing a high-island breeding refugium for many seabirds, including ‘Ua‘u kani (Wedge-tailed shearwater, *Puffinus pacificus*), ‘Ā (Red-footed booby, *Sula sula*), Mōlī (Laysan albatross, *Phoebastria immutabilis*), Koa‘e ‘ula (Red-tailed tropicbird, *Phaethon rubricauda*), Koa‘e kea (White-tailed tropicbird, *Phaethon lepturus*), and the threatened ‘A‘o. The predator-free fenced unit is the first predator-free managed unit on the island of Kaua‘i, benefits existing breeding Nēnē (Hawaiian goose, *Branta sanvicensis)* and Mōlī, and satisfies the criteria identified by the population and conservation status working group of the Agreement on the Conservation of Albatrosses and Petrels (ACAP) for seabird restoration sites.

Both short and long-term conservation actions are needed to support recovery of these seabirds. Long-term options include increased protection of existing breeding colonies, minimization of collisions with power lines, and the development of multiple breeding colonies in protected areas. However, given population declines and continued predation at known colonies, short-term management actions for immediate implementation are necessary to reduce the potential for extirpation from the island.

1.2 Legal and Policy Guidance

Implementing management actions to reduce the potential local extirpation of the ‘Ua‘u is consistent with the following laws and policies: the Endangered Species Act of 1973; the Migratory Bird Treaty Act of 1918; and the National Wildlife Refuge System Administration Act of 1966, as amended. Many other Federal laws, executive orders, Service policies, and international treaties govern the Service and Refuge System lands. For additional information on laws and other mandates, a list and brief description of Federal laws of interest to the Service can be found in the Laws Digest at http://www.fws.gov/laws/Lawsdigest.html. These outlined management actions also implement or are consistent with various state laws, including the Hawai‘i Endangered Species law.

Endangered Species Act of 1973
The ESA provides for the conservation of threatened and endangered species of fish, wildlife, and plants by Federal action and by encouraging the establishment of state programs. It provides for the determination and listing of endangered and threatened species and the designation of critical habitats. The implementation of management actions to reduce the potential for extirpation of ʻUaʻu from Kauaʻi is clearly consistent with the intent of the ESA.

Migratory Bird Treaty Act of 1918
Established in 1918 with subsequent amendments and provisions following, this act protects migrating birds between the U.S. and Canada, Mexico, Union of Soviet Republics, and Japan. This act makes it illegal for people to "take" migratory birds, their eggs, feathers or nests (take is any means or in any manner, any attempt at hunting, pursuing, wounding, killing, possessing or transporting any migratory bird, nest, egg, or part thereof). The implementation of management actions to reduce the potential for extirpation of the ʻUaʻu from Kauaʻi is consistent with the purposes of the Migratory Bird Treaty Act as it would support conservation of migratory seabirds.

Hawaiʻi Endangered Species law
Hawaiʻi Revised Statutes (HRS) Chapter 195D (Hawaii's Endangered Species law) provides for the protection of threatened and endangered species of fish, wildlife, and plants within Hawaiʻi. Implementing management actions to reduce the potential for extirpation of ʻUaʻu from Kauaʻi is clearly consistent with Chapter 195D.

National Wildlife Refuge System Administration Act of 1966, as amended
The National Wildlife Refuge System Administration Act states that the Director of the USFWS shall provide for the conservation of fish, wildlife and plants, and their habitats within the Refuge System as well as ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained. Under the Administration Act, each refuge must be managed to fulfill the Refuge System mission as well as the specific purpose(s) for which it was established. The implementation of social attraction techniques or chick translocation of ʻUaʻu to a protected area at KPNWR is consistent with the purposes of both the Refuge System in general and KPNWR in specific as it is proposed for the benefit of endangered seabirds.

1.3 Relationship to Other Planning Efforts

The goals and objectives of existing national, regional, state, and ecosystem plans and/or assessments were considered in the development of this EA. This section summarizes some of the key related planning efforts.

Newell's Shearwater and Hawaiian Petrel Recovery: A Five-Year Action Plan (Holmes et al. 2011).
This draft action plan and work-plan provide specific recovery objectives for the ʻUaʻu. The development of translocation protocols, including the identification of priority translocation sites, is identified as priority 1, essential to prevent extinction.

Hawaiian Dark-Rumped Petrel and Newell's Manx Shearwater Recovery Plan (USFWS 1983).
This recovery plan for the ʻUaʻu and ʻAʻo (using the previously recognized names for these species) provides specific recovery objectives for the ʻUaʻu and identifies the need for additional nesting colonies, translocation of chicks, and the development of additional colony establishment techniques (like acoustic attraction or use of decoys) as recovery objectives.

Kauaʻi Seabird Habitat Conservation Plan (KSHCP) (in prep.).
The KSHCP is currently being developed by DLNR-DOFAW, in cooperation with USFWS, to provide interested parties with a streamlined approach to secure legal authorization of unavoidable incidental take of endangered and threatened seabirds on the island of Kauaʻi. Biologists involved with the development of the KSHCP have been involved in the development of the alternatives identified in this EA, and their input has been invaluable in contributing information necessary for the long-term recovery of ʻUaʻu. Funding associated with the approved Kauaʻi Island Utility Cooperative's Short-Term Habitat Conservation Plan and Incidental Take Permit has supported current seabird management by KESRP. Management actions to reduce the potential for extirpation of ʻUaʻu from Kauaʻi would be consistent with, and complementary to, the goals of the HCP as actions to protect a local endangered species.

Regional Seabird Conservation Plan (USFWS 2005).
The purpose of this plan is to identify USFWS priorities for seabird management, monitoring, research, outreach, planning and coordination. It lists the need to control non-native predators in Hawaiʻi where they negatively affect seabird populations, especially in ʻUaʻu colonies.

Kauaʻi Island-wide Draft Recovery Plan (USFWS in prep.).
This draft recovery plan is being developed to incorporate all listed and candidate species on the island of Kauaʻi, including those in other recovery plans. In total, it will address 172 species. For multi-island species, the recovery plan will only address the recovery needs and actions for Kauaʻi populations. Management actions to reduce the potential for extirpation of ʻUaʻu from Kauaʻi would be consistent with the Kauaʻi Island-wide Draft Recovery Plan.

Hawaiʻi's Comprehensive Wildlife Conservation Strategy (CWCS) (Mitchell et al. 2005).
Hawaiʻi's CWCS reviews the status of the full range of the state's native terrestrial and aquatic species (over 10,000 of which are found nowhere else on Earth) and provides management recommendations for their continued conservation. Hawaiʻi's Species of Greatest Conservation Need include all native terrestrial animals, all endemic aquatic animals, additional indigenous aquatic animals identified as in need of conservation attention, a range of native plants identified as in need of conservation attention, and all identified endemic algae. Management actions identified to reduce the potential for extirpation of ʻUaʻu from Kauaʻi would be consistent with the CWCS.

Hono o Nā Pali Natural Area Reserve (NAR) Management Plan (DOFAW 2011).
Hono o Nā Pali NAR was designated in 1982 to preserve native natural communities on Kauaʻi and includes perennial streams, riparian and ridgeline habitat, lowland and montane forests, rare

plants, endemic stream fauna, and forest bird and seabird habitat. Some of the largest existing breeding colonies of ʻUaʻu are located within Hono o Nā Pali NAR. Management actions to reduce the potential for extirpation of ʻUaʻu from Kauaʻi would be consistent with the Hono o Nā Pali NAR management goal to protect, maintain, and enhance the Reserve's unique natural, cultural and geological resources, and support the objective of habitat protection and rare species restoration and the objective to collaborate with external partners to address joint management needs (including seabird recovery).

Kīlauea Point NWR Draft Comprehensive Conservation Plan (CCP) (USFWS 2015).
The Draft CCP describes a vision for the KPNWR and presents goals, objectives, and strategies for management over the next 15 years. It specifically recognizes the importance of Kīlauea Point NWR to seabird populations threatened with the effects of climate change and the threats non-native mammals pose to these species. Management actions to reduce the potential for extirpation of ʻUaʻu from Kauaʻi would be consistent with the Draft CCP as actions to protect a local endangered species.

Kauaʻi Watershed Alliance Management Plan (2005).
The Kauaʻi Watershed Alliance (KWA) is a group of public and private landowners working cooperatively to manage critical watershed lands on Kauaʻi. Most of the existing known ʻUaʻu colonies are located on lands within the KWA. The KWA completed a watershed management plan in 2005, which includes resource management programs such as ungulate management, weed management and watershed monitoring. Management actions to reduce the potential for extirpation of ʻUaʻu from Kauaʻi would be consistent with the KWA Management Plan as actions to support the recovery of a listed species found within the KWA.

1.4 Scoping and Public Participation

Scoping for the project builds on existing conservation efforts relating to the ʻUaʻu and ʻAʻo. The Newell's Shearwater and Hawaiian Petrel Recovery: 5 Year Action Plan (2011) was developed by a team of seabird biologists from DLNR-DOFAW, PCSU, and USFWS. Review and input was solicited from partners and stakeholders throughout the state and from scientific peers within and outside of Hawaiʻi, with the intent to ensure that the objectives and actions outlined in the Action Plan were embraced by those involved in land management and the conservation of these seabirds. Translocation was identified as a high priority action essential to prevent extinction.

Planning for this project began in 2012. Biologists from Pacific Rim Conservation and KESRP traveled to New Zealand to view ongoing translocation projects and talk with local experts. A draft translocation plan for both ʻUaʻu and ʻAʻo was developed in 2014 and circulated for review and comment to seabird biologists, partners and stakeholders throughout the state, and to scientific peers. The translocation plan was further refined and is attached as Appendix C.

Also in 2012, planning began for the Nihoku Ecosystem Restoration Project at KPNWR, identified as the translocation site. Because this predator-proof fenced unit would benefit existing listed and migratory species at KPNWR, a separate EA was prepared to cover fence construction and habitat restoration within the unit. However, the possibility of using the area as a future translocation site for ‘Ua‘u and ‘A‘o was discussed in the EA, at public presentations given at the Kīlauea Neighborhood Association and the Princeville Public Library, and at public meetings associated with the draft CCP. To date, public response to the concept of using Nihoku as a translocation site for ‘Ua‘u has been entirely positive.

1.5 Scope of Analysis

Issues raised during the scoping process and addressed in this EA include:
- purpose and need for conservation action;
- alternatives considered;
- impact of alternatives on other listed species; and
- likelihood of success.

1.6 List of Permits Required

Table 1.1 Summary table of permits required

Applicable permits	**Alternative A: current management**	**Alternative B: social attraction**	**Alternative C: chick translocation combined with social attraction (preferred alternative)**
Endangered Species Recovery Permit (USFWS)	X (monitoring, banding)	X (banding)	X (moving and handling of chicks)
Natural Area Reserves permit (DLNR)			X (removal of chicks from NAR)
State Scientific Collection/Protected Wildlife permit (DLNR)	X (monitoring, banding)	X (banding)	X (moving and handling of chicks)

Chapter 2. Alternatives Including the Proposed Action

2.1 Alternatives Considered but Eliminated

Alternatives were developed based on the best available scientific data and applicable conservation principles, involving consultation with seabird biologists and existing planning documents. Early in the alternatives development process, the following actions were considered to reduce the potential for extirpation of the ‘Ua‘u from Kaua‘i but were ultimately eliminated from further consideration in this EA for the reasons provided.

Captive propagation was eliminated from consideration, as there are no known instances of successful captive propagation of shearwaters or petrels. While insectivorous passerines have been successfully reared from eggs and chicks, bringing wild birds into captivity generally has a high likelihood of failure. And, in contrast to passerines, seabirds regularly fly long distances around the ocean, and at-sea tracking data indicates that breeding petrels alternate between short, nearby foraging trips and long distance trips around the North Pacific while feeding chicks (Maui Nui Seabird Project 2015; Adams and Flora 2010). ‘Ua‘u require a pre-laying exodus at sea to gather nutrients to make eggs, which would be extremely difficult to replicate in captivity without negative impacts to the birds. Finally, captive propagation has never been identified as a priority item in any recovery plan or other strategy document developed by local experts familiar with ‘Ua‘u, their population status, and threats to their survival.

Egg translocation was considered, but eliminated due to lack of feasible potential foster parents (existing breeding seabirds with similar nesting season, feeding, and brooding habits), limited documented use of this method for petrels, and the possibility that ‘Ua‘u chicks would imprint on the wrong species and not select conspecifics as mates. Although ‘Ua‘u was prehistorically sympatric with multiple coastal species, the use of other species as potential foster parents could result in initial competition for nesting space during establishment of ‘Ua‘u at the new colony, similar to that observed between Wedge-tailed shearwaters and ‘A‘o at KPNWR.

The installation of fencing (either predator-proof or ungulate-proof) to enable enhanced predator control at existing colonies was evaluated for consideration, but was eliminated for purposes of this EA due to topographical challenges, the need for further discussions with landowners, and costs. Ungulate-proof fences have less stringent requirements than predator-proof fences for ground preparation, slope, stream crossings, and use of natural barriers, but both types of fencing require site-specific evaluation to determine feasibility of construction, to avoid sensitive biological or cultural features, and to minimize impacts on public access. Cost estimates range from approximately $150,000-$200,000 per mile for ungulate-proof fencing in remote areas, and from approximately $850,000 to $1,100,000 per mile for predator-proof fencing in remote areas (T. Rubenstein pers. comm.; Young and VanderWerf 2014). Some fencing is already planned or under construction by other parties, and other areas are still under consideration. This alternative remains a potential future management action, and if implemented, the site-specific environmental impacts would be evaluated separately, in conformance with NEPA and HRS Chapter 343 as appropriate.

Alternative restoration sites (for both Alternative B and Alternative C) were explored. The site selection process requires assessment of both biological constraints to breeding success (e.g., risks from predators, food limitation and human disturbance) and logistic constraints (e.g., landowner support, costs and practicality of establishing a field camp, a plan for long term stewardship). In addition, under the guidelines (Jacobs et al. 2015) established by the population and conservation status working group of the Agreement on the Conservation of Albatrosses and Petrels, a seabird restoration site should fulfill the following criteria:

- a suitable geographic site with respect to topography, access to the ocean, strength and direction of prevailing winds, ease of take-off and landing, nesting substrate, reasonable distance to adequate foraging grounds, and sufficient elevation to preclude periodic inundation from storm waves;
- free of predators and invasive species harmful to Procellariiformes, or fenced (prior to translocations) to exclude such species, or a regular control program to remove those detrimental species;
- surveyed prior to the translocation for the presence of any endemic species (flora or fauna) that could potentially be disturbed by the project, or that could influence the success of colony establishment;
- adjacent to a cliff, elevated above the surroundings, or relatively free of man-made or natural obstructions that could inhibit fledging and arrivals and departures of adults;
- relatively accessible to biologists, to facilitate delivery of supplies and monitoring;
- designated for long-term conservation use;
- a site for which other conflicting uses (e.g., local fishing, aircraft operations, city lights, busy roads, and antennae, etc.) have been considered and conflict avoidance measures are feasible;
- be free of, or have minimal, known human threats to the species (such as light attraction or power lines) within its immediate vicinity.

The Nihoku predator-free unit at KPNWR meets these criteria and is immediately available for a translocation project; it is hoped that other sites would be developed in the future.

2.2 Alternative A. No-action Alternative: Continue Existing Management

Under this alternative, current management efforts would continue. Current monitoring activities related to the ʻUaʻu on Kauaʻi are conducted primarily by KESRP and include: auditory surveys at night or early morning at specific times of the year when the birds are most active and vocal to try to determine the location of breeding colonies; radar surveys to track the number of birds moving from the sea to inland breeding colonies to try to determine how the population is changing over time; monitoring known burrows in several remote locations and collecting data on fledging success rates, reasons for failure and site fidelity; banding individual birds to develop a better understanding of individual survival rates; and tracking individual birds at sea using geolocators and satellite tracking tags.

These monitoring activities are run in conjunction with seabird specific management actions at four colonies, in Hono o Nā Pali NAR (North Bog, Pihea, and Pōhākea) and Upper Limahuli

Preserve, including predator control and invasive plant removal, funded primarily through the KIUC Short-Term Habitat Conservation Plan. Efforts are currently underway to increase predator control operations in these areas, with increased funding and staff. Good Nature self-resetting traps were recently installed in the NAR sites. Initial data indicates that these traps could reduce black rat numbers; cat control efforts within Upper Limahuli Preserve demonstrate that cat predations can be reduced through intensive predator control (this site had 0 cat predations in 2014). (Raine and Banfield 2015a-d).

A breeding colony at Hanakāpīʻai within Hono o Nā Pali NAR was recently discovered; monitoring of the colony has begun and more intensive management (such as predator control) is planned for 2016. However, most of the known ʻUaʻu breeding colonies on Kauaʻi, particularly at low-elevation sites, do not receive site-specific management (i.e., monitoring of individual burrows or predator control) primarily due to the low number of active burrows at these sites.

2.3 Alternative B. Social Attraction

Alternative B is composed of the existing management activities outlined in Alternative A, combined with social attraction techniques to try to develop a new protected breeding colony at KPNWR, within the fenced predator-free unit at Nihoku. Social attraction aims to lure adult birds to restoration sites with the goal of establishing breeding colonies. More than 95% of seabirds are colonial, meaning they are attracted to breeding sites by the presence of conspecifics and other seabirds (Jones and Kress 2012). They may also be lured using decoys (models of adults, chicks, and eggs), sound recordings, mirrors, scents, and artificial burrows, all of which replicate features of an established colony (Jones and Kress 2012).

Acoustic playback of non-aggressive vocalizations, decoys, and other enticements that simulate the colony from a distance lure prospecting seabirds to new nesting habitat (Jones and Kress 2012). Acoustic attraction can be used for both diurnal and nocturnal species, but decoys have been used only for diurnal species (Jones and Kress 2012). Decoys sometimes are supplemented with mirrors to give the appearance of a larger colony and movement in the colony, making prospecting birds into living decoys (Jones and Kress 2012).

Fifty artificial burrows, using designs similar to those used in New Zealand for other Procellariiformes species made with lighter weight plastic, would be installed at KPNWR within the Nihoku unit. The burrows are 5-sided plastic boxes with open bottoms, hinged lids, and corrugated plastic PVC tubes for burrow entrances. A solar-powered sound system, continuously playing species specific call from existing breeding colonies would also be established. Decoys would be considered based on the results of decoy trials on Maui.

2.4 Alternative C. Chick Translocation Combined with Social Attraction (Preferred Alternative)

Alternative C is composed of the existing management activities outlined in Alternative A and the social attraction techniques outlined in Alternative B, combined with the annual translocation of ʻUaʻu chicks to the fenced predator-free unit at Nihoku, as outlined in more detail in the translocation plan attached as Appendix C. Translocation has been part of the recovery planning since 1967 for ʻUaʻu (USFWS 1983), and the development of translocation protocols, including identification of priority sites for translocation, is ranked as priority 1 in the interagency draft 5-year Action Plan for Newell's Shearwater and Hawaiian Petrel Recovery (Holmes et al. 2011).

Chick translocation refers to the active movement of chicks to a new location, and is most successful for species that exhibit high natal site philopatry, do not exhibit post colony-departure care, or for restoration projects without a large nearby source colony (Jones and Kress 2012). Translocated chicks return as adults to breed and often lure immigrant conspecifics to the translocation site, thereby increasing colony numbers (Jones and Kress 2012). Most translocation projects translocate downy chicks to release sites and hand-rear them to fledging age (Jones and Kress 2012). Because adults are not moved with chicks (as adults would readily abandon the new site), chicks are hand-fed with dietary supplements until they fledge (Jones and Kress 2012). Both advances in chick rearing methods over time and variability in marine conditions during the project argue for multiple years of translocations to increase odds for success (Jones and Kress 2012).

The translocation plan is highly influenced by the successful translocations of burrow-nesting Procellariids undertaken in New Zealand since the early 1990s and adheres to the guidelines for the appropriateness, planning, implementation and monitoring of such actions written for ACAP (Gummer 2013) and those adopted by the IUCN Species Survival Commission in 2012. The proposed ʻUaʻu translocation would be divided into several distinct phases: (1) site preparation; (2) identification of source donor colonies; (3) collection and retrieval of chicks from source locations; (4) chick care at the translocation site; and (5) translocation monitoring and assessment. The total cost of the proposed action is approximately $95,000 in year one and $64,000 annually for each year of translocation, which would total $351,000 over five years and $671,000 over ten years.

<u>Site preparation</u>
All mammalian predators (e.g., cats, rats, and mice) were removed from the Nihoku site in 2014. Site preparation at the Nihoku translocation site would involve habitat restoration (removal of invasive vegetation and replanting native vegetation suitable for both the existing breeding bird populations (Mōlī and Nēnē) and for future seabird colonists) and the installation of artificial burrows. These burrows would recreate the physical condition of natural burrows (length, depth, temperature, substrate, and humidity) as much as possible, using modifications of designs successfully used in New Zealand.

<u>Identification of source donor colonies</u>
Beginning in 2012 and continuing through 2014, KESRP conducted surveys and burrow searching activities for potential source colonies at locations around Kauaʻi, including Makaleha, Kāhili/Kalāheo, North Fork Wailua, and Koluahonu. Initially surveys were concentrated in low-elevation colonies considered to most at risk from extirpation. However, the results of these surveys indicated that these low-elevation areas were not suitable as source populations for translocation because (1) the colonies are now sparsely populated, with the remaining breeding

birds spread out over large areas, resulting in time-intensive searching conditions with extremely low success rates in locating burrows and (2) the colonies have populations of introduced predators with no ongoing predator control, and intensive searching for burrows could make the remaining birds vulnerable to increased predation pressure (Raine at al. 2014).

In 2014, search efforts focused on a small number of lower elevation colonies with the highest number of birds and known colonies in higher elevation areas, to maximize search effort in areas where larger number of birds are present. The higher elevation sites had predator control teams operating within the management area, providing some protection to nesting birds. Surveyed colonies in 2014 included North Fork Wailua, Kāhili/Kalāheo, Upper Limahuli Preserve, and Hono o Nā Pali NAR (Raine et al. 2014).

The sites surveyed in 2014 were ranked in terms of suitability as a source population for translocation using the following criteria: (1) presence of a breeding colony (necessary for use as source colony); (2) number of known burrows present (sites with higher numbers of active burrows considered more appropriate as source colonies); (3) threat level (sites with high threat levels considered more appropriate as source colonies due to increased risk of extirpation); (4) on-site predator control (sites with control considered more appropriate as source colonies to reduce risk of predation associated with the search and monitoring of burrows required to inform translocation in any given year); and (5) accessibility (sites with easy access considered more suitable than sites with more difficult access).

Based on the information gathered about these colonies, the highest ranked potential source colonies were in Hono o Nā Pali NAR (Pihea, North Bog, Hanakāpīʻai, and Pōhākea) and Upper Limahuli Preserve (Raine et al. 2014). Except for Hanakāpīʻai, these sites all have an existing breeding colony with high call rates and higher numbers of active burrows, medium threat levels, ongoing predator control, and moderate accessibility. Hanakāpīʻai is a recently discovered colony, with a number of active burrows, high threat levels and no current predator control. For year one, three colonies within the NAR are proposed as source colonies: Pihea, North Bog, and Pōhākea due the number of burrows, accessibility, and on-site predator control. In future years, chicks may be relocated from Upper Limahuli Preserve and Hanakāpīʻai, or from as-yet undiscovered colonies that rank as suitable source colonies using the above criteria.

<u>Collection and retrieval of chicks from source locations</u>
Burrow-nesting seabird chicks are thought to gain cues from their surroundings during the emergence period shortly before fledging, and then use that information to imprint on their natal colony (locality imprinting). Chicks that have never ventured outside natal burrows can be successfully translocated to a new colony location. Success is optimized if chicks spend the greater proportion of the rearing period with parents before being moved. For ʻUaʻu, age of first emergence is 15.8±0.94 days before fledging (n=22, min=7, max=29) (KESRP unpublished data). This would likely be in late October to beginning of November based on on-going data collection at active burrows using Reconyx cameras. Trips would be made to source colonies in mid October, and chicks that appear to be in good health meeting minimum criteria (wing cord and mass measurements) would be selected for translocation.

In New Zealand, for established translocation programs for burrowing seabirds, a maximum of 100 chicks per year is considered appropriate, with this number reduced for the first year of a project or for a team new to seabird translocation. If the species has never been translocated before, protocol in New Zealand is to conduct a trial transfer of a small number of chicks (e.g., ≤10) to test burrow design and hand-rearing methods, which is the approach proposed for ʻUaʻu. If fledging in the first year is successful, then increasing the number of chicks to be moved in each of the next four years to a maximum of 20 chicks per year would be considered.

Chicks would be removed from different burrows in different years (i.e., chicks would not be removed from the same burrow in consecutive years), to maximize representation of different parents and enhance the genetic variety of the translocation group. The transfer box design used for most burrow-nesting petrel transfers in New Zealand would be used, which is based on a standard pet (cat) box and provides enough space and ventilation to prevent overheating and to minimize wing and tail feather damage. One box per chick would be used. Chicks would be removed from burrows by hand and placed into transfer boxes, which would then be transported from the source colony by helicopter. Transfer is estimated to take a maximum of 4 hours.

Chick care at the translocation site

Upon arrival at the Nihoku translocation site, each chick would be banded and placed in an artificial burrow. The artificial burrows utilize designs similar to those used in New Zealand for other Procellariiformes species but with lighter weight plastic. The burrows are 5-sided plastic boxes with open bottoms, hinged lids, and corrugated plastic PVC tubes for burrow entrances. Sandbags are placed on top to regulate temperatures, and entrances would be initially blocked to ensure that newly translocated chicks do not wander out of the burrow prematurely (these would be removed based on chick development and proximity to fledging).

Chicks would be visited each day and burrows visited to assess the overall welfare of the chick, signs of regurgitation or abnormal excrement, and signs of digging in the blockaded burrow. Then chicks would be removed from the burrow individually, weighed, measured, fed, and returned to the burrow. The food recipe and amount is based on information from New Zealand translocations, rehabilitation of ʻUaʻu, and the information known about the natural diet of the ʻUaʻu. Sterilization procedures would be followed to prevent infection to the translocated chicks.

The incorporation of social attraction techniques (specifically acoustic playback of calls and potentially use of decoys) would be used to provide visual and auditory stimuli to the developing chicks, which may encourage future return to the translocation site at breeding age. In addition, the use of social attraction may lure other potential breeders, such as juveniles, to the translocation site.

Translocation monitoring and assessment

Monitoring is planned for all facets of the chick translocation, including continued monitoring of all the colonies used as source colonies to assess potential effects of chick removal, monitoring of chicks after transfer and before fledging, and monitoring the translocation site to determine the proportion that return after fledging, the number of prospecting birds from other colonies, and hopefully, reproductive success at the translocation site.

Table 2.1 Metrics of success and targets used to evaluate success of preferred alternative

Success metric	**Target**
% chicks that survive capture and transfer to translocation site	90% in year one; 100% afterwards
Body condition of fledged chicks	Wing and mass measurements ≥ wild chicks
% chicks that fledge from the new colony	70% in year one; 80% afterwards
% translocated chicks that return to the translocation site	≥ 27% (rate of survival in wild colonies)
# birds fledged from other colonies that visit the translocation site	> 0
# birds fledged from other sites that recruit to the translocation site	>0
Reproductive performance of birds breeding in the translocation site	Hatching and fledging rates ≥ wild colonies (39-61%; Simons 1985)
Natural recruitment of chicks raised completely in the translocation site	≥ 27% (rate of survival in unprotected colonies) and by year 10

Chick translocation is a long-term (5-10 year) management action to be implemented over the course of multiple years, and would be done in coordination with partners, including seabird biologists from New Zealand with expertise in translocations, KESRP, USFWS, DLNR-DOFAW, the American Bird Conservancy, the National Fish and Wildlife Foundation, and others. Translocation programs generally need 5 or more years of translocation cohorts to ensure adult returns reach a critical mass large enough to form a colony, and at least a decade to monitor results (Jones and Kress 2012).

Chapter 3. Affected Environment

3.1 Physical Environment

3.1.1 Existing managed colonies

Four high elevation colonies, three within Hono o Nā Pali NAR (Pihea, North Bog, and Pōhākea) and one within Upper Limahuli Preserve, are currently under active management. Hono o Nā Pali NAR, managed by the State of Hawaiʻi Natural Area Reserves program of DLNR-DOFAW, occupies 3,579 acres in the Hanalei and Waimea Districts on the island of Kauaʻi and is surrounded by the Nā Pali Coast State Wilderness Park, the Nā Pali Kona Forest Reserve, the Alakaʻi Wilderness Preserve, and private lands (including Upper Limahuli Preserve). Upper Limahuli Preserve encompasses approximately 400 acres and is owned and managed in perpetuity as a Conservation Area by the National Tropical Botanical Garden (NTBG). The colonies in both areas are primarily accessible by helicopter.

The NAR stretches from sea level to the Reserve's highest point at Pihea (4,282 ft), while Upper Limahuli Preserve extends from about 1,600 ft elevation to 3,300 ft at the summit of Hono o Nā Pali. Most of the soils are categorized as rough mountainous land with rocky outcroppings (rRo). Rainfall depends greatly on topography, and annual rainfall averages from 80 inches in the coastal lowlands to more than 160 inches in the upland forests (Giambelluca et al. 1986). Streams within the NAR include parts of the upper tributaries for the Waimea River (Kawaikōī tributary), Hanakāpīʻai, Hanakoa stream, and all of the Waiahuakua and Hoʻolulu streams; Upper Limahuli Preserve contains Limahuli Stream. There is no data on ambient air quality specific to the NAR or Upper Limahuli Preserve.

3.1.2 Seabird translocation site

The proposed seabird translocation site is composed of approximately 7.8 acres within Kīlauea Point NWR, at the northernmost tip of the island of Kauaʻi. It faces the ocean, on sloping land (averaging 22% slope, ranging to nearly 40% slope) above steep sea cliffs, with an elevation range of approximately 140 to 250 feet above mean sea level. Soils at the site are categorized as LhE2 (Lihue silty clay, 25- to 40-percent slopes) (5.1 acres), rRo (rock outcrop) (2.2 acres), and LhD (Lihue silty clay, 15- to 25-percent slopes) (0.4 acres) (USDA NRCS 2013). The translocation site is indicated to receive approximately 60 inches of annual rainfall (Giambelluca et al. 1986). There are no natural waterways, such as streams, within the translocation site. The Pacific Ocean is adjacent to the translocation site at the base of steep cliffs. There is no data on ambient air quality specific to the translocation site.

3.2 Biological Environment

3.2.1 Existing managed colonies

Hono o Nā Pali NAR and Upper Limahuli Preserve can be broadly classified as containing three major ecosystems, including lowland mesic, lowland wet, and montane wet forest (DOFAW 2011, NTBG 2008). The upper portion of the NAR containing the managed colonies is an eroded plateau with a series of ridges and valleys covered with ʻōhiʻa (*Metrosideros polymorpha*) dominated montane wet forest communities. The steeper slopes contain an understory of uluhe (*Dicranopteris linearis*, *Sticherus owhyensis*, and *Diplopterygium pinnatum*) with emergent native trees and shrubs (DOFAW 2011). Upper Limahuli Preserve contains forest ecosystems classified as ʻōhiʻa/ʻōlapa (*Cheirodendron* spp.) forest and ʻōhiʻa/uluhe fern forest (NTBG 2008).

Hono o Nā Pali NAR and Upper Limahuli Preserve contain four of the largest known ʻUaʻu breeding colonies, and combined, these sites fledged 60 ʻUaʻu chicks in 2014 (Raine and Banfield 2015a-d). The breeding colony at Hanakāpīʻai within Hono o Nā Pali NAR was recently discovered and more intensive monitoring will occur in 2015.

Table 3.1. Summary of reproductive success and predation at existing managed colonies

Site	# HAPE Burrows	# Active 2014	# Confirmed breeding 2014	# Documented predations 2014 (egg or chick /adult)	# Fledged 2014
HNP: North Bog	79	76	56	15 (12/3)	27
HNP: Pihea	46	39	30	6 (3/3)	23
HNP: Pōhākea	10	10	6	4 (3/1)	2
Upper Limahuli Preserve	23	17	13	1 (1/0)	8

Data derived from Raine and Banfield 2015a-d.

In general, both the NAR and Upper Limahuli Preserve are considered high-quality native habitat, supporting over 100 rare plant taxa (DOFAW 2011, NTBG 2008). The NAR is equally significant to forest birds and seabirds for three reasons: 1) the large elevation gradient provides habitat diversity; 2) there is a high proportion of native plant communities, thus providing high quality bird habitat and greater robustness to disturbances (i.e., invasive plant invasion); and 3) the remoteness of Hono o Nā Pali puts greater distance between known threats to birds including powerlines, and artificial lights (DOFAW 2011). The NAR is designated critical habitat for 69 rare plant taxa and two forest birds, as well as critical habitat for the following ecosystems: lowland mesic, lowland wet, dry cliff, wet cliff and montane wet (DOFAW 2013).

The plateau area of the NAR adjacent to the Alakaʻi Wilderness Preserve is important habitat for native forest birds, including the endangered ʻAkekeʻe or Kauaʻi ʻĀkepa (*Loxops caeruleirostris*), the endangered ʻAkikiki or Kauaʻi Creeper (*Oreomystis bairdi*), ʻApapane (*Himatione sanguinea*), Kauaʻi ʻElepaio (*Chasiempis sclateri*), Kauaʻi ʻAmakihi (*Hemignathus kauaiensis*), ʻAnianiau (*Hemignathus parvus*), and ʻIʻiwi (*Vestiaria coccinea*)(DOFAW 2011). ʻApapane and ʻIʻiwi have been observed within Upper Limahuli Preserve (NTBG 2008). Surveys of the rim of the upper plateau of the NAR above Wainiha and Kalalau valleys have found breeding locations and activity for three rare species of seabirds: the endangered ʻUaʻu, the threatened ʻAʻo, and a candidate for listing, the ʻAkēʻakē (Bandrumped storm petrel, *Oceanodroma castro*) (DOFAW 2011); breeding colonies of both ʻUaʻu and ʻAʻo are confirmed within Upper Limahuli Preserve (NTBG 2008). The coastal areas and cliffs also provide habitat for other seabirds, including ʻĀ (brown booby, *Sula leucogaster*), Koaʻe ʻula, and Koaʻe kea (DOFAW 2011).

The NAR also contains habitat for the pueo (Hawaiian owl, *Asio flammeus sandwichensis*). The koloa maoli (Hawaiian duck, *Anas wyvilliana*) occurs in the NAR and Alakaʻi swamp area, and the endangered ʻōpeʻapeʻa has been observed by researchers on occasion in the NAR and in Upper Limahuli Preserve. Both the NAR and Upper Limahuli Preserve contain undiverted perennial streams with unique native aquatic biota, and limited sampling of terrestrial invertebrates indicates a diversity of native species. Numerous non-native birds are present in the NAR and Upper Limahuli Preserve, including barn owls, Japanese white-eye (*Zosterops japonicus*), melodius laughing-thrush (*Garrulax canorus*), and Erckel's francolin (*Francolinus erckelii*), as are a variety of non-native mammals including feral pigs (*Sus scrofa*), black-tailed deer (*Odocoileus hemionus columbianus*), feral goats (*Capra hircus*), rats (*Rattus* spp.), mice (*Mus musculus*), and cats (*Felis catus*).

3.2.2 Seabird translocation site

The translocation site contains primarily non-native invasive vegetation, low in stature (<12') and aside from a small grassy patch in the center of the fenced unit, it is relatively uniform in composition. Habitat restoration is currently underway, removing the dominant non-native plant Christmasberry (*Schinus terebinthifolius*) and replanting native species (suitable for both seabirds and Nēnē) in approximately 15% (1.1 acres) of the translocation site each year. All introduced mammalian predators (dogs, cats, rats, and mice) have been successfully removed from the translocation site.

The only native birds currently found in the translocation site are a small number of breeding Nēnē, Mōlī, and ʻĀ. The Hawaiian hoary bat, or ʻŌpeʻapeʻa (*Lasiurus cinereus semotus*) has been sighted within KPNWR, but no bats have been observed at or around the translocation site (USFWS unpublished data).

The endangered Nēnē is observed within the translocation site with regularity. Five nests were discovered in the area previous to fence construction, and two nests were active inside the fenced unit in 2015. Peak breeding occurs mainly October to March and molting March to June, when adults become flightless for 4 to 6 weeks while they grow new flight feathers. During this period, they become secretive and are extremely vulnerable to attacks by introduced predators. During the rest of the year, from June to September, Nēnē disperse or flock with other family groups on the Refuge and in non-breeding areas where young Nēnē have opportunities to find mates.

Nine nests of Mōlī were discovered in the general area previous to fence construction, and two nests were initiated inside the fenced unit in 2015. Typically Mōlī select nest sites close to vegetation and nests vary from a scrape to a ring-like structure comprised of sand, vegetation, and debris. Eggs are laid November - December and chicks fledge in July; no post-fledgling care is provided by parents.

‘Ua‘u kani are the most abundant bird species at KPNWR, but are currently absent from the translocation site. The closest colony is more than 250 meters away. It is possible that once the habitat has been prepared and artificial burrows are installed, they may attempt to move into the translocation site.

Non-native barn owls have been observed within the translocation site and are known predators of seabirds (including confirmed predation events of ‘Ua‘u). They have been documented killing large numbers of ‘Ua‘u kani in the Refuge.

3.3 Cultural and Historic Resources

The following steps were taken to identify potential cultural and historical resources: (1) general literature search on the cultural importance of or legends associated with seabirds, and ‘Ua‘u in particular; (2) review of the 2013 Archaeological Assessment for construction of the fence at Nihoku and 1989 Archaeological Inventory Study for Kīlauea Point NWR expansion; (3) review of the Cultural Impact Assessment included in the 2013 Final EA for the Hono o Nā Pali NAR Management Plan; (4) review of cultural resources summarized in the 2008 Final EA for the Revised Master Plan for Limahuli Garden and Preserve; and (5) informal consultation with a variety of organizations and individuals who might have additional information or insight, including the Kīlauea Point Natural History Association, Office of Hawaiian Affairs, State Historic Preservation Division, and others.

3.3.1 Cultural significance of ‘Ua‘u

Seabirds themselves are of cultural importance, valuable to Native Hawaiians for feathers and food (Boynton 2004, Xamanek Researches 1989). Native Hawaiians considered the ‘Ua‘u a delicacy, and chicks were considered taboo (kapu) and reserved for consumption by chiefs, or ali‘i (NPS 2008, Shallenberger 2009). Chicks were removed from their burrows with forked sticks, and nets were used to catch adult and young birds in the nesting areas (NPS 2008, Shallenberger 2009). Fossil remains indicate that both adults and young birds were harvested on a large-scale (NPS 2008). In modern times, seabirds continue to play a role for aku (skipjack tuna) fishermen, as the behavior of seabirds at sea tells what is happening in the ocean miles away, providing valuable information for a successful fishing trip (Boynton 2004).

3.3.2 Existing managed colonies

A summary of the relevant findings contained in the Cultural Impact Assessment for Hono o Nā Pali NAR is as follows: The valleys of the Nā Pali coast were inhabited and intensively cultivated by the Native Hawaiians, and overland trails connected many of these valleys. The upland portions of Hono o Nā Pali NAR are less studied, but cultural impact assessments have been prepared for the adjacent, and similarly forested and remote, upland areas of the Alakaʻi and Wainiha. The studies indicate that in addition to containing the trails used to connect areas, the upland forests were sacred to Hawaiians and were used for traditional and cultural practices such as bird hunting, harvesting timber, collection of plants for medicinal use, and ceremonial purposes (hula, oli, or chant) (DOFAW 2013). No evidence of habitation or burial was found in the adjacent remote upland areas; instead these areas bear significance as the wao nahele (forested zone) containing native plants and animals of cultural value and as wahi pana (legendary places) (DOFAW 2013).

A summary of the relevant findings for Upper Limahuli Preserve is as follows: No archaeological sites are known or anticipated to be found within Upper Limahuli due to the inaccessibility of the perched upper valley and a review of existing oral histories, surveys, and field observations (NTBG 2008).

3.3.3 Seabird translocation site

The translocation site contains no documented cultural resources (Cultural Surveys Hawaiʻi 2013).

3.4 Social and Economic Conditions

3.4.1 Existing managed colonies

Hono o Nā Pali NAR is state-owned land set aside as a natural area reserve, designated to "preserve in perpetuity specific land and water areas which support communities, as relatively unmodified as possible, of the natural flora and fauna, as well as geological sites of Hawaiʻi" (HRS Chapter 195). Public access is allowed for recreational and cultural uses, and current public use primarily involves hiking, bird watching and hunting. Most visitors stay on marked hiking trails and away from the remote steep areas containing the existing seabird colonies (DOFAW 2011). Upper Limahuli Preserve is private property that is not open for general public use; access to the area is severely limited by the steep terrain and surrounding topography, and hunters do not use the area (NTBG 2008).

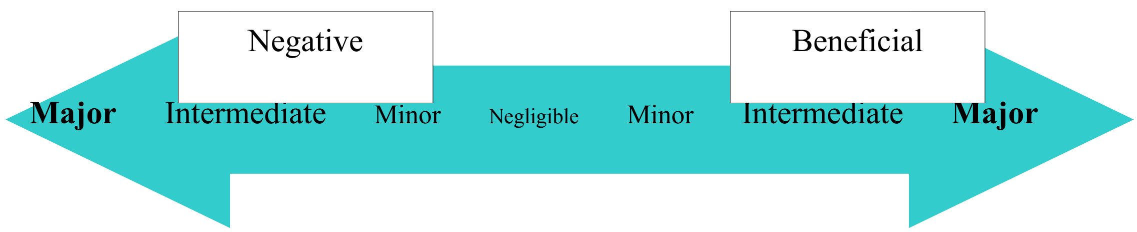
3.4.2 Seabird translocation site

Kīlauea Point NWR hosts over 500,000 visitors a year and is among the top 5 in public visitation for all national wildlife refuges. However, tours to the translocation site are limited to less than 5 guided educational interpretive tours annually. The translocation site is located in an area designated for wildlife protection and restoration and is closed to the public. The site is 1.6 km southeast of the Kīlauea Point Lighthouse (the primary visitor attraction at the Refuge) and is accessible only via a gated roadway (used for management purposes).

Chapter 4. Environmental Impacts

4.1 Overview of Effects Analysis

This chapter assesses the potential effects to the physical and biological environment and to cultural and socio-economic resources as a result of implementing each alternative. The qualitative terms moderate (intermediate), minor, and negligible are used to describe the magnitude of the effect. To interpret these terms, intermediate is a higher magnitude than minor, which is of a higher magnitude than negligible.



The terms below were used to describe the scope, scale, and intensity of effects.

Neutral or Negligible. Resources would not be affected (neutral effect), or the effects would be at or near the lowest level of detection (negligible effect). Resource conditions would not change or would be so slight there would not be any measurable or perceptible consequence to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource. If a resource is not discussed, impacts to that resource are assumed to be neutral.

Minor. Effects would be detectable but localized, small, and of little consequence to a population, wildlife or plant community, other natural resources; social and economic values, including recreational opportunity and visitor experience; or cultural resources. Mitigation, if needed to offset adverse effects, would be easily implemented and successful based on knowledge and experience.

Intermediate or Moderate. Effects would be readily detectable and localized with measurable consequences to a population, wildlife or plant community, or other natural resources; social and economic values, including recreational opportunity and visitor experience; or cultural resources within the Refuge but not readily detectable or measurable beyond the Refuge. Mitigation measures would be needed to offset adverse effects and could be extensive, moderately complicated to implement, and probably successful based on knowledge and expertise.

Significant or Major. Region-wide effects would be obvious and would result in substantial consequences to a population, wildlife or plant community, or other natural resources; social and economic values, including recreational opportunity and visitor experience; or cultural resources. Extensive mitigating measures may be needed to offset adverse effects and would be large-scale in nature, possibly complicated to implement, and may not have a high probability of success. In some instances, major effects would include the irretrievable loss of the resource.

4.2 Effects on the Physical Environment

Topics addressed under the physical environment section include effects to soils, water quality, and air quality. No significant effect is expected on the physical environment under any of the alternatives.

Negligible disturbance to soils would occur under all alternatives through trampling of soils by those conducting monitoring of bird nesting sites based on observations from similar monitoring activities occurring throughout the state. Minor localized ground disturbance would result under Alternatives B and C from the installation of artificial burrows at the translocation site.

No impacts to water quality or quantity are anticipated under any alternative; any work would be conducted during the dry season, there would be no work in or around existing streams, and activities associated with all alternatives (e.g., monitoring, acoustic attraction, moving chicks) are not anticipated to result in any discharges into existing streams or the ocean.

No impacts to air quality are anticipated under any of the alternatives.

4.3 Effects to the Biological Environment

Topics addressed under the biological environment section include effects to federally listed species, native vegetation, birds, invertebrates, and invasive species. No significant effect is expected on the biological environment under any of the alternatives.

4.3.1 Effects on federally listed species

ʻUaʻu - endangered
Given the decline of ʻUaʻu in the wild, none of the alternatives assures the continued existence of the ʻUaʻu on Kauaʻi. It is possible that the existing breeding population could disappear simply due to predation, collision with power lines, natural causes of mortality, or habitat modification. The longer management intervention is delayed, the more likely that options would cease to be available.

Under Alternative A, the population of the ʻUaʻu on Kauaʻi would be expected to continue to decline. Current management is focused on the four of the largest known ʻUaʻu colonies on Kauaʻi as outlined earlier and provides localized protection from predation to breeding birds in those four colonies. ʻUaʻu colonies are typically located in remote, difficult to manage areas, and the majority of known colonies are not actively managed with predator control due to cost, topography, access, and lack of landowner permissions. Predator control efforts have been refined over the previous decade and can be further implemented efficiently and with good effect, but expansion of these efforts to all known colonies would require increased funding and staff yet still could not eliminate predation entirely from any particular colony. Moreover, should the mongoose become more firmly established on Kauaʻi, population declines could be expected to accelerate, reducing the availability of other management options such as social attraction or translocation. On its own, this alternative fails to take advantage of the potential of the newly constructed predator-proof fence to host a protected breeding colony, and no new protected colonies would be established.

Under Alternative B, a breeding colony could be established over time at a new location protected from predators through implementation of social attraction techniques to lure prospecting birds to the translocation site. There is no risk associated with handling birds, and the success or failure of social attraction can be evaluated relatively quickly since it focuses on juvenile and adult birds (rather than waiting years for chicks to mature and reach breeding age). Social attraction can lure in juveniles from unprotected colonies, reducing the potential loss of that breeder to predation at its natal colony. However, the probability of success for this alternative is unknown: Buxton et al. (2014) suggests the most influential variable affecting recolonization is a source colony within a range of 25 km, and the Nihoku translocation site lies at the boundary of that range (20-25 km from potential source colonies). Social attraction has not been tried with ʻUaʻu; it is uncertain whether prospecting ʻUaʻu would respond to acoustic playback or decoys. And, there may not be enough pre-breeding recruits on Kauaʻi to support the development of a sustainable breeding colony through social attraction alone. Finally, the use of social attraction as the primary management response could foreclose the future use of chick translocation if social attraction is unsuccessful. The ʻUaʻu population is expected to continue to decline over the short-term, and the increased difficulty associated with locating active ʻUaʻu burrows in declining colonies would hamper future efforts to identify candidate chicks for translocation. Moreover, should the mongoose become more firmly established on Kauaʻi, population declines could be expected to accelerate, reducing the availability of translocation as a management option. Because the probability of success for this alternative is unknown, a minor to moderate positive effect on ʻUaʻu would be anticipated.

Under Alternative C, chick translocation has great potential to establish a breeding colony of ʻUaʻu at a new accessible location protected from predators; in other translocations of Procellariids, translocated chicks have returned to the translocation site as adults to breed and these colonists have lured immigrant conspecifics (Jones and Kress 2012). Removal of chicks from existing colonies would not be anticipated to negatively impact the source colony. A maximum of 100 ʻUaʻu chicks would be moved over a five year period (a total of 10-20 per year depending on the year), with only 2 to 5 nestlings removed from any individual site. Any impact to the source colony due to the removal of chicks is anticipated to be minor in comparison to existing conditions, as the numbers proposed for removal are comparable or less than the annual number of chicks and eggs lost to predation. Moreover, in other seabird species, much higher proportions of nestlings have been transported from at-risk colonies to protected sites for conservation purposes (including 100% of the chicks produced by the critically endangered Cahow (*Pterodroma cahow)* and Taiko (*Pterodroma magentae*) since each is restricted to a single colony), with no measurable negative impact on the source colony (Carlisle et al. 2012).

Table 4.1 Summary comparison of chicks removed for translocation vs. lost to predation

Site	Active burrows 2014	Maximum number of chicks to be removed per year	Number of eggs/chicks lost to predation in 2014
HNP: North Bog	76	10	12
HNP: Pihea	39	5	3
HNP: Pōhākea	10	5	3
U. Limahuli Preserve	17	5	1
TOTAL	105	20*	19

Data derived from Raine and Banfield 2015a-d
* The maximum number of chicks per colony adds up to more than the total maximum chicks to be relocated per year, to provide flexibility in selecting chicks for relocation and to make changes year to year based on site-specific considerations.

Under Alternative C, desertion of breeding pairs in future years from burrows where chicks have been removed for translocation purposes or where chicks have been lost to predation is not anticipated. In a number of other translocation studies, it was found that adults return the following year despite the removal of their chick prior to fledging. There is also some suggestion in related species that by removing chicks before fledging, the breeding pair may have a higher survival rate as they are able to spend more time foraging for self-maintenance compared to pairs raising a chick (VanderWerf and Young 2011). In ʻUaʻu burrows currently monitored on Kauaʻi, breeding pairs return in subsequent years after their chicks have been lost to predation and successfully fledge young in the following year (KESRP unpublished data). To reduce the potential for impact on breeding pairs, chicks will not be selected for translocation from the same burrow in consecutive years.

Under Alternative C, moving chicks carries the risk that the birds may be injured or may die during capture and transport and/or may not acclimate to the translocation site, and ultimately may die from stress or related illnesses. However, based on recent developments in New Zealand, the likelihood of success for chick translocation has improved since the concept was identified as a recovery objective for ʻUaʻu in 1983. Translocation has been particularly successful with multiple *Pterodroma* and *Puffinus* species (Miskelly et al. 2009). Eight species from four different genera were translocated by 2008 in New Zealand, and several more species have been translocated since, including successful translocations for the highly endangered Bermuda Cahow and New Zealand Taiko (Miskelly et al. 2009; Gummer 2013; T. Ward-Smith pers. comm.). Techniques have been developed and refined to a level where health issues are minimal and transferred chicks fledge at measured condition parameters similar to, or exceeding those, of naturally raised chicks (Gummer 2013). Hand-rearing methods are now well-established for many seabird species, especially burrow nesters, leading to 100% fledging success in many cases (Jones and Kress 2012). Implementing these established techniques would be anticipated to reduce the potential for harm from overheating, injury in the carrying containers, or stress from unfamiliar stimuli. To further minimize negative impacts, any injuries or problems attributable to the translocation process would be evaluated and appropriate modifications made to prevent future injuries or problems.

Most of the New Zealand translocations have been undertaken too recently to have published reports of return rates and breeding success of fledged chicks. However, by 2009, 11 species of petrel of five genera had been recovered back at release sites following translocation (Miskelly et al. 2009). For ʻUaʻu, data indicates that 27% of fledglings return to their birth colony as adults; similar returns are anticipated under Alternative C, as translocated chicks who fledge would face the same challenges as wild birds when at sea. If 100 birds fledge over five years, the translocation site could have a population of 27 (translocated) breeding birds when the last cohort of translocated chicks returns, as well any additional birds who colonize due to the social attraction techniques or the return of the translocated birds. This would be comparable in size to some of the known (declining) wild colonies, and because these birds would be breeding in a protected predator-free area, breeding success in the predator-free translocation site should be higher than that in existing colonies. The long-term conservation benefit of a protected breeding colony is important as the restored colony could be expected to grow (rather than decline) over time, and the health and status of the population in the translocation site would be much easier to monitor than the populations found in remote mountainous areas. In sum, Alternative C would have a moderate positive impact on ʻUaʻu.

Under Alternatives A and C, ʻUaʻu could be harmed through damage to nesting habitat by repeat visits (although this has not yet occurred at any managed site), disturbance resulting in temporary or permanent burrow desertion by adults (although this has never been recorded in areas currently monitored on Kauaʻi at a frequency of up to eight visits per year), and the creation of trails to burrows that could be used by introduced predators. To prevent or minimize negative impacts,

- Existing trails would be followed whenever possible, and the creation of new trails would be avoided;
- Any burrows damaged accidentally by trampling would be repaired;
- Use of aromatic lotions or insect repellants that may leave a human scent trail and lead introduced mammalian predators directly to burrows would be avoided;
- The total number of visits to each burrow would be minimized and burrow cameras would be used to monitor reproductive success or access viability of any given burrow for use as a source bird for translocation;
- Intensive monitoring and burrow searching would be concentrated, where possible, in areas with existing predator control activities.

<u>Nēnē - endangered</u>
There are no anticipated impacts on the Nēnē under Alternative A.

Under Alternatives B and C, an existing Nēnē breeding population at KPNWR within the fenced unit could be affected by the establishment of a new breeding ʻUaʻu population. Noise and activities associated with social attraction (such as the installation and playing of acoustic recordings of petrel calls) or chick translocation (installation of artificial burrows, feeding and monitoring translocated chicks prior to fledging) may temporarily disrupt the activities of the Nēnē. The installation of the social attraction system and fifty artificial burrows would occur in August 2015; social attraction recordings would be projected after installation in August 2015 through November and annually thereafter from late February (just before breeding ʻUaʻu arrive) through November (estimated fledging of ʻUaʻu), while actions related to chick translocation would be concentrated in October to November. Thus, the projection of acoustic recordings and chick translocation and feeding and monitoring activities would overlap with the Nēnē peak breeding season (October - March).

KPNWR supports the largest population of breeding Nēnē in the state. Endangered Nēnē nest throughout the Refuge at average densities as high as 4 pairs per hectare. To minimize disturbance to breeding pairs and families during the Nēnē breeding season, biologists feeding ʻUaʻu chicks at the translocation site would enter the fenced unit on foot through an alternative access easement (75m to project site) in the adjacent SeaCliffs neighborhood instead of driving 1200m multiple times daily through Nēnē Crater Hill breeding grounds, all Nēnē nests and broods in the fenced unit would be mapped and monitored, and any pairs or family groups in the translocation area would be avoided (e.g., speakers and burrows would not be installed in known Nēnē nesting areas, as Nēnē have high site fidelity and would likely return to that site). With these mitigation measures in place, minor impacts on Nēnē would be anticipated and existing Nēnē populations would be expected to remain stable and continue on their current trajectories of increasing populations on Kauaʻi.

<u>ʻAʻo – endangered</u>
Because ʻAʻo breeding habitat does overlap with ʻUaʻu, management and monitoring activities associated with Alternative A also provide valuable protection from predators and information on the status of ʻAʻo. No activities likely to harm or affect ʻAʻo are proposed under Alternatives B or C, but under Alternatives B and C, the possibility exists that social attraction aimed at ʻUaʻu could lure juvenile ʻAʻo into the protected translocation site, providing a benefit to the ʻAʻo. Similarly, the planning and experience gained from implementation of the ʻUaʻu chick translocation proposed in Alternative C is anticipated to inform and support future ʻAʻo chick translocation efforts.

<u>ʻŌpeʻapeʻa – endangered</u>
The ʻŌpeʻapeʻa is not currently found at the translocation site. There are no anticipated impacts on the ʻŌpeʻapeʻa under any of the alternatives as ʻŌpeʻapeʻa populations have not been impacted by existing activities (Alternative A) and no activities likely to harm or affect endangered ʻŌpeʻapeʻa are proposed under Alternatives B or C.

<u>Listed Forest birds - endangered</u>
There are no anticipated impacts on endangered forest birds under any of the alternatives as existing forest bird populations have not been impacted by existing activities (Alternative A) and no activities likely to harm or affect endangered forest birds are proposed under Alternatives B or C.

<u>Listed plants and invertebrates</u>

No rare plants or invertebrates occur at the translocation site. Thus, there are no anticipated impacts on listed plant or invertebrate taxa under any alternative as existing rare plant populations have not been impacted by existing activities (Alternative A) and no disturbance of rare plants or invertebrates or rare plant or invertebrate habitat is proposed under Alternative B or C.

4.3.2 Effects on native vegetation

Under all of the proposed alternatives, there would be no prolonged or intensive impact to the native vegetation. It is possible that activities associated with all three alternatives may increase the opportunity for the introduction of non-native weeds into these areas, but invasive species protocols in place for current management actions (Alternative A) would be incorporated into all other alternatives as appropriate. Documenting and eliminating as soon as possible any incipient populations of new non-native weed species would be part of the biological monitoring program. Absent the introduction or spread of non-native weed species, native vegetation communities should remain intact and unaffected, with no measurable consequences, under all three alternatives.

4.3.3 Effects on native animals

Under all the proposed alternatives, there is no anticipated negative impact to native animals found at the managed colony sites, as native animals have not been affected by existing activities (Alternative A) and no new activities likely to affect native animals are proposed by Alternatives B or C.

Under Alternative A, overflying ʻUaʻu would be expected to continue to fly over the translocation site and would not be expected to naturally recolonize the area or begin nesting on their own. Other overflying seabirds, such as ʻĀ (known to nest nearby) and ʻUaʻu kani (known to nest in similar areas), might colonize on their own without management intervention. The breeding population of the Mōlī currently using the translocation site could be expected to double within 3 years of predator removal.

Under Alternatives B and C, with the exception of possibly ʻUaʻu kani, no negative interactions are anticipated between ʻUaʻu and any other native animal at the translocation site. Mōlī eggs are laid November – December, generally after the fledging of ʻUaʻu, and Mōlī chicks fledge in July soon after ʻUaʻu arrive at the breeding colony. Mōlī are known to co-exist with numerous other smaller species of burrow nesting seabirds without negative impacts to either species, and it expected that they would have limited interaction with ʻUaʻu.

While ʻUaʻu kani have been known to displace ʻAʻo from breeding burrows (USFWS unpublished data; Raine and Banfield 2014) and potentially inflict harm on ʻAʻo adults, this has not been documented in ʻUaʻu, possibly because there are no coastal ʻUaʻu nesting areas. While there are no ʻUaʻu kani nesting currently in the translocation site, they do nest nearby (closest colony is <250m, and one pair is immediately outside the fenced area). It is possible that once the habitat has been prepared and artificial burrows are installed, they may move into the area. In the fossil record prior to human contact, the two species nested in similar habitats, and thus it is assumed that they are able to coexist. Monitoring inter-species interactions would be part of the biological monitoring program, and actions such as blocking the entrance to the artificial burrows to prevent displacement by ʻUaʻu kani would be incorporated as needed.

4.3.4 Effects on non-native species

The control of harmful non-native species in an ongoing problem throughout the state of Hawaiʻi. Indeed, predation by non-native species is a primary threat to ʻUaʻu survival. All alternatives incorporate some level of control of introduced predators to reduce or eliminate the threat of predation to ʻUaʻu. Under Alternative A, control of introduced predators would be directed to cats, pigs, rats, or barn owls found at existing managed colonies; under Alternatives B and C, control of introduced predators would be directed to monitoring for incursions by cats, pigs, and rodents and preventing predation by barn owls at the translocation site. Under Alternative B, control during the recruitment period would be done on an as-needed basis; under Alternative C, barn owl control would be implemented during the translocation period while ʻUaʻu chicks are on-site. All methods of predator control would be consistent with State and Federal law and incorporate best practices identified through knowledge and experience. The effect on predatory non-native species would be minor, especially given that the non-native species were introduced to Hawaiʻi and that these species exist in sizable populations throughout Kauaʻi and the state.

4.4 Effects to Cultural and Historic Resources

The National Historic Preservation Act (NHPA), as amended, establishes the Federal Government's policy on historic preservation and the programs through which that policy is implemented. An impact to cultural resources would be considered significant if it adversely affects a resource listed in or eligible for listing in the National Register of Historic Places. In general, an adverse effect may occur if a cultural resource would be physically damaged or altered, isolated from the context considered significant, or affected by project elements that would be out of character with the significant property or its setting. Title 36 CFR Part 800 defines effects and adverse effects on historic resources.

None of the alternatives is anticipated to result in negative impacts to archaeological or historical resources. There are no resources eligible or listed on the National Register of Historic Places within the project areas identified under Alternatives A, B, or C. Management actions proposed under all three alternatives are either located in areas in extremely remote, rugged, heavily vegetated mountainous terrain with no known archaeological or historic sites (managed colony sites), and/or an area that has been previously surveyed (KPNWR translocation site) and proposed management actions under all alternatives are limited in scope and involve minimal ground disturbance (e.g., monitoring, capture of chicks, installation of artificial burrows). However, should evidence of any archaeological or cultural properties be encountered, any activity that could impact the discovered property would immediately cease and the appropriate parties would be consulted immediately.

The native Hawaiian ecosystems and the native species found therein are an essential part of the overall cultural landscape. To some in the community, natural resources are cultural resources. Seabirds, and in particular the ʻUaʻu, have cultural importance to Native Hawaiians and fishermen. The purpose of the project is the long-term recovery of the ʻUaʻu, and a project designed to prevent the extinction of a native seabird could be considered to have a positive impact on cultural resources.

4.5 Effects to Social and Economic Resources

The existing managed colonies are managed for conservation, and aside from their importance as watershed, these lands are not currently used for resource extraction. These areas are zoned as protected conservation land and due to their remoteness, are not heavily used for recreation. Similarly the proposed translocation site (KPNWR) is within a protected national wildlife refuge, in a portion of KPNWR that is not currently open for public visitation, is not currently planned for recreational use, and is not along the transit route to areas that are open for public visitation (e.g., Kīlauea Point Lighthouse). All alternatives are consistent with the current land use and zoning, and no changes in land use would occur under any of the alternatives.

No local communities occur in either the area of the existing managed colonies or the proposed translocation site. None of the alternatives would result in changes to agriculture, farming, or the visitor industry.

All alternatives are conducted collaboratively with other agencies, educational institutions, or entities. Existing funding for Alternative A includes both state and USFWS (section 6) funds, funding from the KIUC Short-Term Habitat Conservation Plan, and private funding. Funding sources for Alternatives B and C include a grant awarded by the National Fish and Wildlife Foundation to the American Bird Conservancy, private funds raised by American Bird Conservancy, funding from mitigation agreements relating to ESA Section 7 consultations on Federal actions on Kauaʻi with real or potential impacts to seabirds, and funding from criminal and civil settlements relating to illegal take of endangered seabirds on Kauaʻi.

Spending to implement the alternatives generates secondary benefits by providing jobs in other industries where monies are spent. Personal spending could include rent, utilities, food, entertainment, food services, gas, etc. A successful chick translocation under Alternative C could encourage additional related conservation spending – either through related conservation actions within the fenced unit (e.g., restoration of rare plant taxa), translocation of other species into the translocation site, or the development of additional predator-free units elsewhere on the island. However, given the size of the project relative to the overall state budget or to other economic inputs into the local economy, effects to economic resources under all alternatives would be expected to be minor.

Table 4.2 Summary of effects

	Alternative A	Alternative B	Alternative C
EFFECTS TO PHYSICAL ENVIRONMENT			
Effects on soils	Negligible	Minor negative	Minor negative
Effects on water	Negligible	Negligible	Negligible
Effects on air quality	Negligible	Negligible	Negligible
EFFECTS TO BIOLOGICAL ENVIRONMENT			
Effects on listed species: ʻUaʻu	Minor positive	Minor to moderate positive	Moderate positive
Effects on listed species: Nēnē	Negligible	Minor	Minor
Effects on listed species: ʻAʻo	Minor positive	Minor to moderate positive	Minor to moderate positive
Effects on listed species: ʻŌpeʻapeʻa	Negligible	Negligible	Negligible
Effects on listed species: forest birds	Negligible	Negligible	Negligible
Effects on listed species: rare plant/invertebrates	Negligible	Negligible	Negligible
Effects on native vegetation	Negligible	Negligible	Negligible
Effects on native animals	Negligible	Negligible	Negligible
Effects on non-native species	Minor negative	Minor negative	Minor negative
EFFECTS TO CULTURAL AND HISTORIC RESOURCES			
Effects on cultural and historic resources	Negligible	Negligible	Negligible
EFFECTS TO SOCIAL AND ECONOMIC RESOURCES			
Effects to social and economic resources	Minor positive	Minor positive	Minor positive

4.6 Cumulative Effects

The Council on Environmental Quality (CEQ) regulations for implementing the provisions of NEPA defines several different types of effects that should be evaluated in an EA including direct, indirect, and cumulative. Direct and indirect effects are addressed above. This section addresses cumulative effects. The CEQ (40 CFR § 1508.7) provides the following definition of cumulative effects:

> *“The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.”*

Cumulative impacts are the overall, net effects on a resource that arise from multiple actions. Impacts can “accumulate” spatially, when different actions affect different areas of the same resources. They can also accumulate over the course of time, from actions in the past, the present, and the future. Occasionally, different actions counterbalance one another, partially canceling out each other's effect on a resource. But more typically, multiple effects add up, with each additional action contributing an incremental impact on the resource. In addition, sometimes the overall effect is greater than merely the sum of the individual effects, such as when one more reduction in a population crosses a threshold of reproductive sustainability, and threatens to extinguish the population.

4.6.1 Related conservation activities

Other conservation actions on the island either directly, or indirectly, benefit ‘Ua‘u. Native ecosystem and watershed management in areas containing known ‘Ua‘u source colonies indirectly and directly benefit ‘Ua‘u by protecting habitat and reducing predation pressure. Hono o Nā Pali NAR management by DOFAW involves habitat protection through the construction of several small fenced enclosures, weed control and habitat restoration within these enclosures, rare species monitoring and collecting, and non-native predator control across 473 acres of seabird habitat (DOFAW 2015). NTBG has focused management activities at Upper Limahuli Preserve since 1992 to mitigate the decline of this once pristine ecosystem caused by the impacts of Hurricanes Iwa and Iniki (wind damage and dispersal of non-native weeds) and the expansion of feral ungulate populations (NTBG 2015). Conservation actions under the Kaua‘i Seabird Habitat Conservation Program, which is developing an island-wide habitat conservation plan for endangered seabirds to address incidental take due to light attraction, directly benefit ‘Ua‘u, and are in various stages of implementation (KSHCP 2015). Conservation actions to protect approximately 144,000 acres of high-elevation rain forest implemented through the Kaua‘i Watershed Alliance indirectly benefit ‘Ua‘u through habitat protection; management programs include fence construction, fence maintenance, ungulate control, invasive weed control and monitoring (HAWP 2015). Mongoose monitoring and trapping efforts by the Kaua‘i Invasive Species Committee directly benefit ‘Ua‘u by delaying or preventing the establishment of mongoose on Kaua‘i. Other conservation actions targeted towards rare plants (e.g., actions by the Plant Extinction Prevention Program, DOFAW, or private landowners) or listed forest birds may also indirectly benefit ‘Ua‘u through fencing, predator control, and native habitat restoration.

Funding for many of these projects varies from year to year. When combined with the management alternatives presented in this DEA, these conservation efforts could result in a significant cumulative positive impact on ʻUaʻu, listed species, and native ecosystems. However, the constant predation pressure presented by introduced non-native mammals and other threats to ʻUaʻu requires these efforts to be maintained over time, and any positive conservation impacts could be eliminated quickly by the introduction of a new predator, a new avian disease, or a natural disaster such as wildfire or hurricane eliminating existing habitat. As such, cumulative effects are minor and beneficial.

4.6.2 Translocation

The translocation of ʻUaʻu chicks would demonstrate the feasibility of seabird translocations as an effective conservation measure in Hawaiʻi to reduce the potential for extirpation or extinction of listed seabirds. Translocation to predator-free areas has been identified as a high priority for the recovery of listed seabird species. As illustration, recent modeling estimated protected habitat requirements to predict a 95 percent or greater probability of survival over 100 years for ʻAʻo and concluded that over 2,700 acres of rodent-free land is needed (USFWS undated).

To date, however, there are few predator-free protected areas within the state, including Makamakaʻole on Maui (2 4-acre units), Kaʻena Point NAR on Oʻahu (approximately 60 acres), and nearly all the offshore islets of Oʻahu, including Mōkapu (10 acres) and Mokoliʻi (12.5 acres) (Hess and Jacobi 2011), but none on or immediately offshore of Kauaʻi. Each of these spaces alone is insufficient to support the recovery of listed and rare seabirds, but might be sufficient to prevent island extirpation, and species extinction, while a sufficiently-sized network is being developed.

If translocation techniques are successful, and additional predator-free units created, these actions would almost certainly benefit other native species, including other endangered species such as the ʻAʻo and listed plants. As such, cumulative effects are minor and beneficial.

4.6.3 Climate change

Global climate change is supported by a continuously growing body of unequivocal scientific evidence. Global forecasting models offer a variety of predictions based on different emission scenarios. The U.S. Government agency Overseas Private Investment Corporation suggests that a further increase in greenhouse gas emissions could double atmospheric concentrations of CO_2 by 2060 and subsequently increase temperatures by as much as 2-6.5°F over the next century. Recent model experiments by the IPCC show that if greenhouse gases and other emissions remain at 2000 levels, a further global average temperature warming of about 0.18°F per decade is expected. Sea level rise is expected to accelerate by two to five times the current rates due to both ocean thermal expansion and the melting of glaciers and polar ice caps. Recent modeling projects sea level to rise 0.59-1.93 feet by the end of the 21st century. These changes may lead to more severe weather, shifts in ocean circulation (currents, upwelling), as well as adverse impacts to economies and human health. The extent and ultimate impact these changes will have on

Earth's environment remains under considerable debate (Buddemeier et al. 2004, Solomon et al. 2007, IPCC 2007).

Small island groups are particularly vulnerable to climate change. The following characteristics contribute to this vulnerability: (1) small emergent land area compared to the large expanses of surrounding ocean; (2) limited natural resources; (3) high susceptibility to natural disasters; and (4) inadequate funds to mitigate impacts (IPCC 2007). Thus, Hawai‘i is considered to have a limited capacity to adapt to future climate changes.

Though none of the management alternatives would have an impact on climate change, the activities associated with them would provide enhanced protection for vulnerable species from some of the anticipated effects of climate change, including the anticipated loss of habitat associated with sea level rise. As such, cumulative effects are negligible to minor and beneficial.

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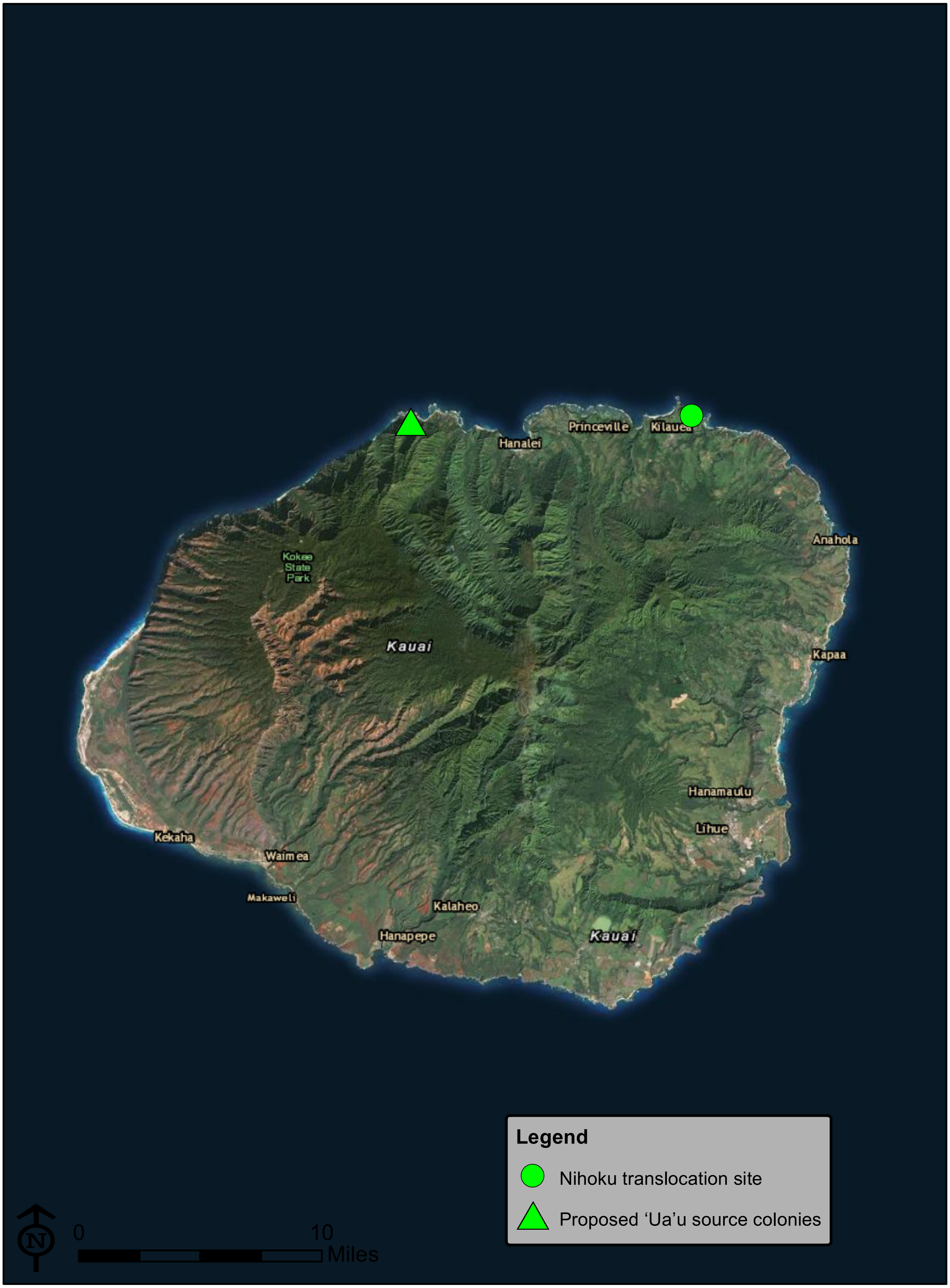
Appendix A: Common Acronyms and Abbreviations

ACAP	Agreement on the Conservation of Albatross and Petrels
CCP	Comprehensive Conservation Plan
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CWCS	Comprehensive Wildlife Conservation Strategy
DLNR	Hawai‘i Department of Land and Natural Resources
DOFAW	Hawai‘i DLNR Division of Forestry and Wildlife
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act of 1973
FONSI	Finding of No Significant Impact
Ft	Feet (foot)
GHG	Greenhouse Gases
HAPE	Hawaiian petrel
HRS	Hawai‘i Revised Statutes
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KESRP	Kaua‘i Endangered Seabird Recovery Project
KPNWR	Kīlauea Point National Wildlife Refuge
KSHCP	Kaua‘i Seabird Habitat Conservation Plan project
KWA	Kaua‘i Watershed Alliance
MHI	main Hawaiian Islands
Mi	Mile(s)
NAR	Natural Area Reserve
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NTBG	National Tropical Botanical Garden
NWR	National Wildlife Refuge
NWHI	Northwestern Hawaiian Islands
PCSU	Pacific Cooperative Studies Unit
T&E	Threatened and Endangered
USC	United States Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Appendix B: Map of translocation site and potential source colonies



Map Source: Brad Stein, oceanmapper@gmail.com Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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Appendix C: Hawaiian Petrel Translocation Plan – Draft

Hawaiian Petrel Translocation Plan - DRAFT

March 2015
Lindsay Young
Pacific Rim Conservation

Andre Raine
Kaua`i Endangered Seabird Recovery Project

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Executive Summary

Hawaiian Petrels (*Pterodroma sandwichensis;* HAPE) are listed under the Endangered Species Act of 1973 and are declining due to habitat degradation by feral ungulates (pigs, goats) and invasive exotic plants, predation by feral domestic cats, pigs, rats, and introduced Barn Owls, and collisions with power lines and structures sometimes exacerbated by light attraction. Protection of petrels on their nesting grounds and reduction of collision and lighting hazards are high priority recovery actions for the species. Given the challenges in protecting nesting birds in their rugged montane habitats however, it has long been desirable to create HAPE populations in more accessible locations that offer a higher level of protection. Translocation to breeding sites within predator proof fences is ranked as priority 1 in the interagency 5-year Action Plan for Newell's Shearwater (*Puffinus auricularis newelli;* NESH) and Hawaiian Petrel. In 2012, funding became available through several programs to create such a population at Kīlauea Point National Wildlife Refuge (KPNWR) which is home to one of the largest seabird colonies in the main Hawaiian Islands. The project was named the "Nihoku Ecosystem Restoration Project" after the area on the refuge where the placement of the future colony was planned. There are four stages to this multi-faceted project: permitting and biological monitoring, fence construction, restoration and predator eradication, followed by translocation of the birds to the newly secured habitat. The translocation component is expected to last five years and translocate up to 50 NESH (10 chicks per year) and up to 100 HAPE (20 chicks per year). Year one would start with HAPE only and NESH would be added in year two. This time frame and minimum number of chicks needed are informed by the life history characteristics of the birds (age of first return is five to seven years), Other translocations of similar species have demonstrated a 12% return rate . Once the project has demonstrated success with high fledging rates, we would seek greater numbers of chicks in year two to increase the potential number of chicks returning to the fully protected site

From 2012-2014 potential source colonies of both species were located with visual, auditory and ground searching methods at locations around Kaua`i. The sites that were selected as sources for Hawaiian Petrel are all within the Hono o Na Pali National Area Reserve system (HNP NAR) and are North Bog, Pohakea, and Pihea. These sites have high call rates, high burrow densities to provide an adequate source of chicks for the translocation, and have active predator control operations in place to offset the impacts of the monitoring required to select translocation burrows which may also potentially attract predators.

A predator proof fence has been constructed at Nihoku and all known HAPE predators have been removed. By the end of summer 2015, 15% of the fenced area within Nihoku will be restored with native vegetation and outfitted with 50 artificial burrows. Habitat restoration will be done in phases (10-15% of the project area in each year) until the majority of the area has been restored. In year one (2015), 10 HAPE chicks that are one month before their expected fledging date (~ mid-September) will be removed by hand from burrows in their montane colonies, and transported by helicopter in a pet carrier to the translocation site. There they will be placed in artificial nest boxes and hand-fed a fish and squid mixture developed by previous translocation projects, until they fledge (~November/ December). Morphometric monitoring, and periodic blood panels will be done to assess chick age and health. Both the translocated chicks, as well as the source colonies will be monitored during and post- translocation to detect any adverse impacts and to document project outcomes. In years 2-5, up to 25 HAPE chicks will be taken each year to provide an adequate translocation cohort for an ultimate goal of translocating

a total of 100 birds over a five year period. In year two (2016), NESH translocations will begin and from then on both species will be done simultaneously.

Once complete, this project will both accomplish multiple refuge-specific goals of seabird and Nene conservation, and will result in a new, secured and accessible breeding population of HAPE which will be crucial to helping to prevent the extinction of this species.**Background**

Translocation as a tool for seabird conservation

Birds in the Order Procellariiformes exhibit strong natal philopatry and high nest-site fidelity. These behavioral traits, along with a protracted nesting period, and ground nesting habit, result in great vulnerability to predation by introduced mammals and exploitation by humans at the breeding colonies (Croxall *et al.* 2012). This vulnerability has led to the extirpation of many island populations of shearwaters and petrels around the world and made the consequences of stochastic events such as hurricanes, volcanic eruptions, epizootics, or fires at the remaining safe breeding sites much more significant (Croxall *et al*. 2012).

Translocation of birds to restore former breeding colonies or to create new colonies that are protected is a strategy that is being used as a conservation measure with increasing frequency, particularly in situations where social attraction techniques are not adequate on their own. Guidelines for the appropriateness, planning, implementation, and monitoring of such actions have been written for the Agreement on the Conservation of Albatrosses and Petrels (ACAP; Jacobs et al. 2013) and similar guidelines were adopted by the IUCN Species Survival Commission in 2012 (http://www.issg.org/pdf/publications/Translocation-Guidelines-2012.pdf). The key methods employed to establish new colonies of burrow-nesting seabirds are acoustic attraction, provision of artificial burrows, and chick translocation.

Translocations involving hand-rearing of burrow-nesting Procellariids have been undertaken around the world, but particularly in New Zealand since the early 1990s (Bell *et al*. 2005; Miskelly and Taylor 2004; Carlisle et al 2012). Eight species from four different genera were translocated by 2008 (Miskelly *et al*. 2009) and several more species have been translocated since (Gummer 2013; T. Ward-Smith, pers. comm.) with each success building upon the last. Furthermore, translocations have been undertaken successfully for highly endangered Procellarids including Bermuda Cahow and New Zealand Taiko, where the World population has numbered at fewer than 100 breeding pairs. Techniques have been developed and established for most of these species to a level where health issues are minimal and all transferred chicks fledge at measured condition parameters similar to, or exceeding those, of naturally-raised chicks (Gummer 2013). Transferring Procellariiform chicks to a new colony site is just the beginning of a long process of colony establishment that depends on survival of the translocated birds, their recruitment to the new colony site, and the social attraction of other pre-breeding individuals that will accelerate the growth of the colony into a viable population.

While successes in early years of translocation development varied (Miskelly et al. 2009), recent years have seen large successes as measured by recruitment of translocated chicks to the translocation site for a variety of species. The Chatham Island Taiko has seen 60% of the 21 chicks transferred over 2007 and 2008 recaptured as adults (M. Bell, Chatham Islands Taiko Trust, pers. comm. 2013), and up to 20% of translocated cohorts of Chatham and Pycroft's petrels translocated in the early-mid 2000s have returned to their respective release sites as adults (H. Gummer and G. Taylor, pers. comm.). Miskelly and Gummer (2013) report that 20 of 240 fairy prions transferred by 2004 were recovered at the release site despite 25 translocated birds being attracted back to the abundant source population. In addition, there has been some recruitment of non-translocated birds at new colony sites of multiple species supporting the use of acoustic attraction (H. Gummer, pers. comm.). Miskelly and Taylor (2004) report that 17% of

Common Diving-Petrels transferred in the late 1990s were recovered at the release site. That project has also shown the highest recruitment rate of non-translocated birds compared to all other New Zealand species, with 80 immigrants recorded within 11 years of the first chick translocation (Miskelly et al. 2009). In summary, the numerous well-documented efforts that have been undertaken over the last 20 years have laid a solid foundation for translocating new species on islands outside of New Zealand.

In Hawaii, there are two seabirds listed under the Endangered Species Act: the threatened Newell's Shearwater (*Puffinus auricularis newelli;* NESH) and the endangered Hawaiian Petrel (*Pterodroma sandwichensis;* HAPE), whose recovery plans specifically list translocation as a highly ranked recovery action. The purpose of this document is to outline the steps required to initiate translocation for HAPE.

Hawaiian Petrel biology

The Hawaiian Petrel, one of the larger *Pterodroma* petrels (434g; Simons 1985), was formerly treated as a subspecies of *P. phaeopyria* and was formerly known as the Dark-rumped Petrel (USFWS 1982) until it was reclassified as a full species due to differences in morphology, vocalization and genetics from birds in the Galapagos Islands (Tomkins and Milne 1991). Hawaiian Petrels previously had a widespread prehistoric distribution throughout the Hawaiian Islands, including low elevation coastal plains on Oahu, Kaua`i (such as Makauwahi Caves), and other islands (Olson and James 1982). Today, the breeding population is estimated to be 6,500-8,300 pairs with a total population of ~19,000 (Spear et al. 1995, Ainley et al. 1997). The population trend is thought to be declining as a result of predation on the breeding colonies by introduced mammals and Barn Owls, collision with power lines, fallout associated with light attraction, and habitat loss. On Kaua'i only a few HAPE are collected each year during the fallout period, but it is not clear whether this is because they are less susceptible than NESH to light attraction or because their main breeding areas are less affected by light pollution. Hawaiian Petrels were listed as endangered under the ESA in 1967.

Hawaiian Petrels are known to breed on Hawai`i Island, Maui, Lanai and Kaua`i, with a small, unconfirmed colony on Molokai (Ainley et al. 1997, Penniman et al. 2008). Known breeding habitat varies. On Haleakala (Maui) and Mauna Loa (Hawaii) Hawaiian Petrels breed in open, rocky subalpine habitat at high-elevation. On Lanai, Kaua`i, West Maui and Molokai, they breed in wet montane forest with dense uluhe fern, similar to NESH (VanZant et al 2014). While at sea during the breeding season, Hawaiian Petrels undertake long-distance, clockwise looping foraging trips over large areas of the North Pacific, sometimes traveling up to 10,000 miles in a single trip (Adams and Flora 2010; KESRP unpublished data). When not breeding, they range widely over the central tropical Pacific (Simons and Hodges1998). Their diet has been extensively studied and is composed primarily of squid (50-75% of volume), followed by a suite of reef fishes that possess pelagic juvenile stages (Simons 1985). Based on the prey species and their behavior, they are assumed to be primarily nocturnal foragers.

Hawaiian Petrels are also a K-selected species and are characterized by a long lifespan (up to 35 years), low fecundity (one chick per year), and delayed recruitment (5-6 years; Simons and Hodges 1998). Most pairs show a high degree of nest site fidelity and often remain with the same mate for consecutive years. A single egg is laid in a burrow or on the ground and parental care is equally distributed between the sexes. The incubation and chick-rearing periods are 55 and 110 days, respectively with some variation in phenology between islands. Chicks are fed an average of 35.6 g of regurgitated squid and fish during the last three weeks of the rearing period, and larger amounts, 55.4-63.3 g, earlier in the rearing period (Simons 1985). Imprinting on the natal site appears to occur after the chick's first emergence from the burrow, which on Kaua`i is 15.8±0.94 days before fledging (n=22, min=7, max=29; KESRP unpub data). Average fledging mass of chicks on Maui is 434g, which is similar to adult weights (424g; Simons 1985), though it should be noted that birds from Kaua`i appear to be smaller in build than those from Maui (Judge et al. 2014). Average wing cord at fledging for birds nesting on Kaua`i is 281.36 ± 10.90 mm (Judge et al. 2014).

Managing threats on their remote colonies is critical, but is also logistically challenging and costly. Creating (and augmenting) colonies in easier to access, safe locations is therefore an important complementary conservation strategy. Although HAPE have not been documented to breed at KPNWR, the restored portions of the refuge (such as that within the fenced area) provides habitat that is comparable to what would have been found in their historic coastal range. The presence of HAPE in the fossil layer indicates that this species was formerly numerous on the coastal plains of Oahu and Kaua`i.

Project background

Given the challenges in protecting nesting seabirds in Kaua`i's rugged interior, it has long been desirable to create populations in more accessible locations that offer a higher level of protection. Translocation has been part of the recovery planning since 1967 for HAPE (USFWS 1982), and translocation within predator proof fences in particular is ranked as priority 1 in the interagency 5-year Action Plan for Newell's Shearwater and Hawaiian Petrel (Holmes et al 2011). In 2012, funding became available to construct a predator-proof fence and conduct a translocation to create such a population at KPNWR. The refuge is home to one of the largest mixed seabird colonies in the main Hawaiian Islands. The project was named the "Nihoku Ecosystem Restoration Project" after the area on the refuge where the fence and translocation are planned. The Nihoku Ecosystem Restoration Project is the result of a partnership between the U.S. Fish and Wildlife Service (USFWS), the Kaua`i Endangered Seabird Recovery Project (KESRP – a project of DOFAW), Pacific Rim Conservation (PRC), the American Bird Conservancy (ABC), and the National Fish and Wildlife Foundation (NFWF). There are four stages to this project: 1) planning, permitting, regulatory compliance, and baseline biological monitoring; 2) fence construction; 3) predator eradication and habitat restoration; and 4) translocation of birds into the fenced area. This translocation plan is the final step in a multi-year planning effort to prepare for the translocation of these species to Nihoku.

This plan has been developed specifically for translocating HAPE from nesting sites on Kaua'i where predation is occurring, to the predator proof fence area at Nihoku within Kīlauea Point National Wildlife Refuge. This plan will outline the information necessary to conduct the translocation. Kīlauea Point National Wildlife Refuge was established in 1985 to "preserve and enhance seabird nesting colonies" and this translocation project will help the refuge meet that objective, as well as accomplishing a major recovery action listed in the recovery plan for HAPE. The translocation of NESH to the refuge will be undertaken via a separate recovery permit.

Translocation site

Translocation site selection and preparation considerations

Conservation practitioners are obligated to ensure that a proposed translocation site is safe and under a land management regime that ideally provides protection in perpetuity with a management plan in place. Based on guidelines set out by the population and conservation status working group of the Agreement on the Conservation of Albatrosses and Petrels (ACAP; Jacobs et al. 2013), a translocation site should fulfill the following criteria:

- A suitable geographic site with respect to topography, access to the ocean, strength and direction of prevailing winds, ease of take-off and landing, nesting substrate, reasonable distance to adequate foraging grounds, and sufficient elevation to preclude periodic inundation from storm waves;
- Free of predators and invasive species harmful to Procellariiforms, or fenced (prior to translocations) to exclude such species, or a regular control program to remove those detrimental species;
- Surveyed prior to the translocation for the presence of any endemic species (flora or fauna) that could potentially be disturbed by the project, or that could influence the success of colony establishment;
- Adjacent to a cliff, elevated above the surroundings, or relatively free of man-made or natural obstructions that could inhibit fledging and arrivals and departures of adults;
- Relatively accessible to biologists, to facilitate delivery of supplies and monitoring;
- Designated for long-term conservation use;
- A site for which other conflicting uses (e.g., local fishing, aircraft operations, city lights, busy roads, and antennae, etc.) have been considered and conflict avoidance measures are feasible;
- Be free of, or have minimal, known human threats to the species (such as light attraction or power lines) within its immediate vicinity.

<u>Site preparation</u>

Ideally, the site selected for the translocation should already have substrate and vegetation structure preferred by the species to be translocated. If there are plants that create collision hazards or block the wind and cause over-heating by preventing convective cooling, they should be removed. For burrow-nesting species, artificial burrows will need to be installed to accommodate translocated chicks and to provide suitable nesting sites for prospecting adults.

It is also important to have a sound system (solar-powered) continuously playing species-specific calls from existing breeding colonies. While decoys are not commonly used for burrowing seabirds, they may help attract birds to the area (this is currently being trialed by First Wind for both NESH and HAPE at two predator proof fenced enclosures at Makmakaole on Maui, although the utility of these decoys in attracting HAPE are not yet known). The decoys and sound system serve two purposes: (1) They provide visual and auditory stimuli to the developing chicks, which may allow them to re-locate the site when they attain breeding age; and (2) The calls and visual cues may attract others of the species to the site. Juveniles that were not reared at the site and have not yet bred may choose to breed at the site, thereby helping to increase the population.

Nihoku site selection
The site selected for Hawaii's first translocation of listed seabirds is the Nihoku section of Kīlauea Point National Wildlife Refuge. This site fulfills all of the criteria described above. Kīlauea Point National Wildlife Refuge was set aside in perpetuity in 1985 by the federal government "to preserve and enhance seabird nesting colonies and was expanded in 1988 to include Crater Hill and Mōkōlea Point" (USFWS). Located at the northern tip of the island of Kaua`i, the 203 acre Kīlauea Point National Wildlife Refuge is home to thousands of nesting seabirds, including Laysan Albatrosses (*Phoebastria immutabilis)*, Red-footed Boobies (*Sula sula)*, Red-tailed Tropicbirds (*Phaethon rubricauda*) and White-tailed Tropicbirds (*P. lepturus*), Wedge-tailed Shearwaters (*Puffinus pacificus)* and several pairs of Newell's Shearwater as well as numerous pairs of Nēnē   or Hawaiian Goose (*Branta sandvicensis*). In addition, many migratory and resident seabird species frequent the area when not nesting. The area is managed for native birds by the U.S. Fish and Wildlife Service through predator control, habitat management (both weeding and outplanting), and fencing

The Nihoku project site consists of approximately 7.8 acres between Crater Hill and Mōkōlea Point, just south of Makapili Rock and approximately 1.5 kilometers northeast of Kīlauea town (Figure 1). Nihoku faces the ocean, on sloping land (approximately 23° slope) above steep sea cliffs. The elevation ranges from approximately 140 to 250 feet above mean sea level; well above all projected sea level rise scenarios as a result of climate change. The area has a natural 'bowl' shape and the orientation facing towards the ocean and prevailing northeast winds make it an ideal location for birds to be directed straight out to sea. The natural cliffs and ridgelines make it ideal for placing a fence to reduce the possibility of birds colliding with the fence, to facilitate take-off for flight and to reduce light pollution from private residences adjacent to the refuge. It was also a relatively simple location on which to build a fence and conduct a translocation due to easy access from a nearby road.

Figure 1: Map of proposed translocation site with pest proof fence alignment in red.

Figure 2: Photograph of the Nihoku site facing northeast

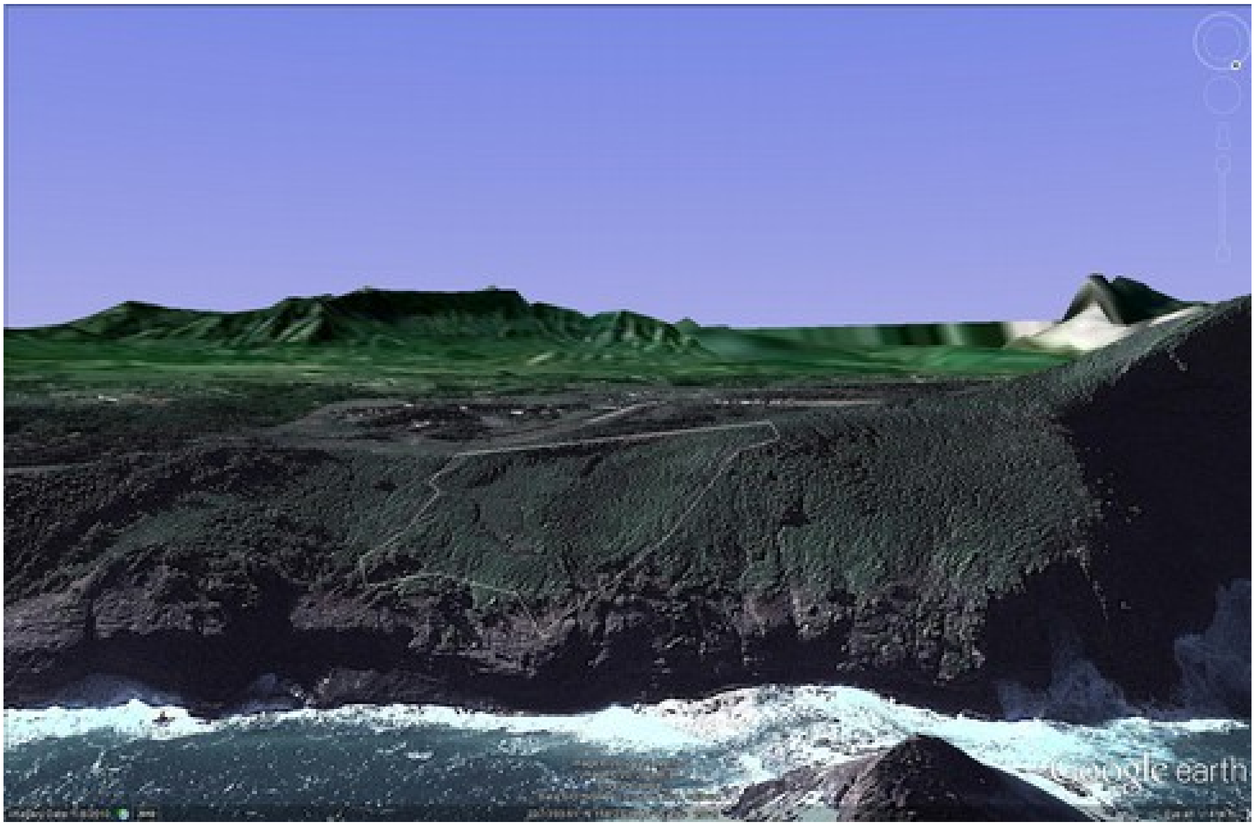

Figure 3: Elevation view of the site facing southwest

Biologically, the site contains few native plants, none of which are listed under the U.S. Endangered Species Act. Plant species composition in the project area is 95% alien species, with Christmas berry (*Schinus terebinthifolius)* being the dominant species at 70% cover. Native plant species present include naupaka, ‘ūlei (*Osteomeles anthyllidifolia)* and hala (*Pandanus tectorius)*. Most vegetation at the site is low in stature (<12’ in height) and, aside from a small grassy patch in the center, relatively uniform in composition, particularly in the canopy strata. While this site is currently being used by a small number of breeding Nēnē and Laysan Albatross (which will benefit from increased protection at the site) it is not being used by any burrowing seabirds as it likely is not suitable habitat for them in the unrestored sections. Wedge-tailed Shearwaters are absent from the immediate site (with the exception of one pair immediately below the fence line) and the closest colony is >250m away. The chosen fence alignment is approximately 728m long and encloses 7.8 acres, which is similar to or larger than most existing translocation sites for related seabird species in New Zealand. The fence design is such that it is high enough that animals cannot jump over it, has a curved hood to prevent climbing, small aperture mesh to prevent squeezing through and a skirt laid just under the ground to prevent digging (see Figure 4). There is a single pedestrian gate and a vehicle gate to facilitate access for monitoring and habitat management.

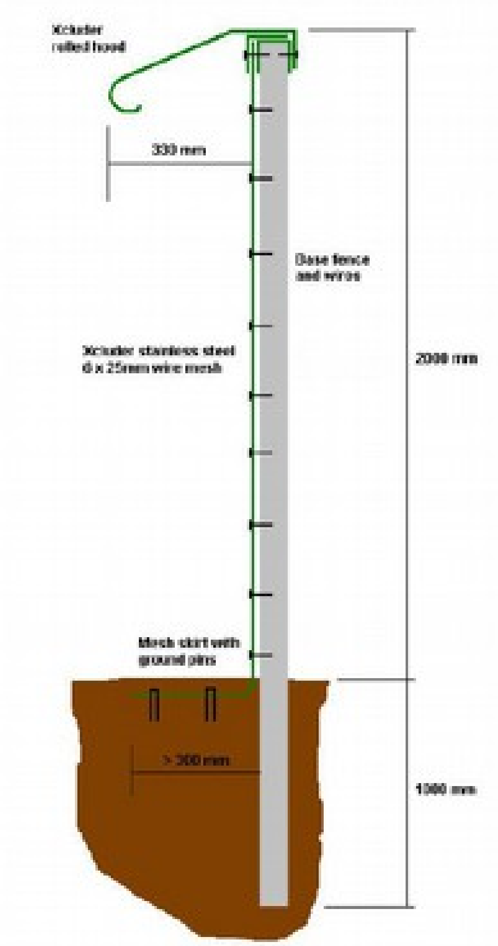

Figure 4: Schematic diagram of the Nihoku pest-proof fence

Nihoku site preparation

Site preparation at Nihoku consisted of three phases: fence construction, predator removal, and habitat restoration. The predator removal and habitat restoration components each have their own implementation plans, and are summarized below.

Fence construction was undertaken by a contractor specializing in fence construction and took three months. Immediately after fence construction, all remaining invasive mammalian predators were removed. Based on monitoring results and regulatory restrictions, a combination of diphacinone in bait boxes spaced 25m apart was used to eradicate rats, and live traps were used to remove cats. These methods were successfully used to eradicate the same mammalian pests from a pest-proof fenced area at Kaena Point in 2011 (Young et al. 2013) and were successful in removing all mammalian predators from Nihoku.

In the summer of 2015, approximately 0.45ha (15%) of the project area will be cleared of invasive alien plants and suitable native species will be out-planted in year one. This is an area that can comfortably fit over 100 artificial burrows at a density typical of *Pterodroma* colonies and still provide adequate open space for optimal take-off and landing zones. In subsequent years, more habitat will be restored with the ultimate goal being more than 50% of the area being dominated by native plant communities. Artificial burrows will only be installed in restored areas.

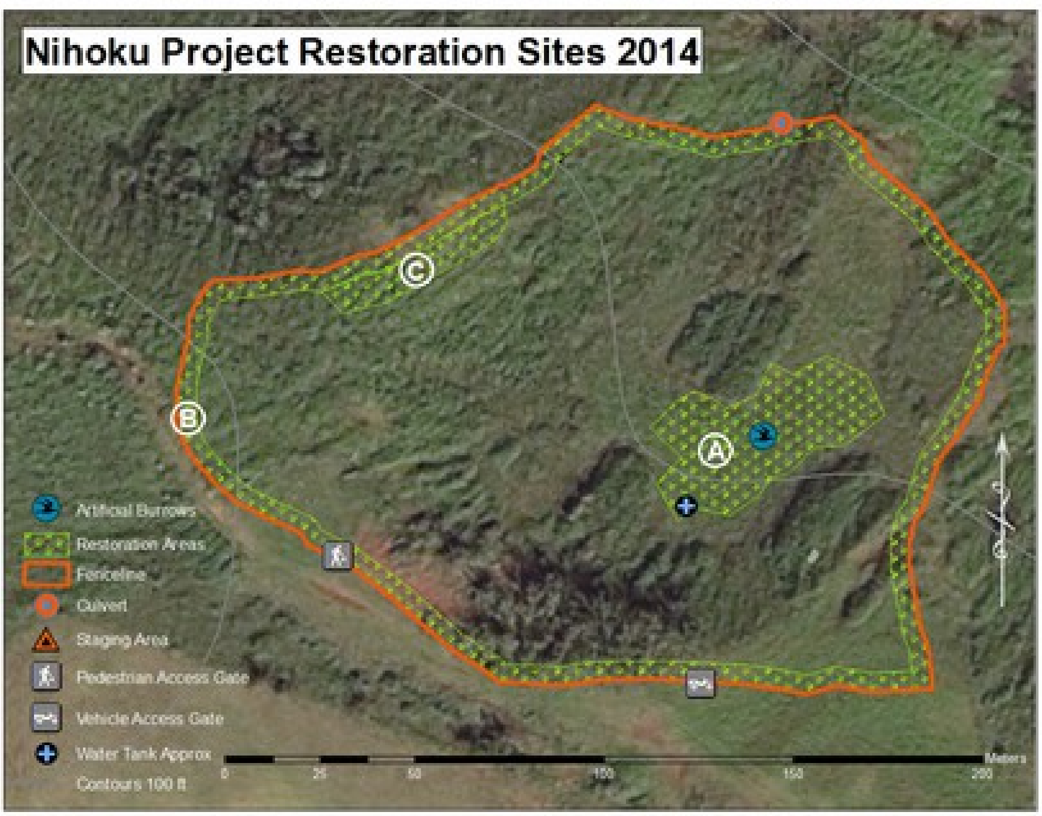

Figure 5: Project area with habitat restoration areas A, B, and C and artificial burrow locations (in restoration area A) shown.

Christmas berry (the dominant invasive) will be mechanically removed or manually cut followed with application of Garlon on the stump, leaving the root system in place to maintain soil integrity while the plant dies. This method has been used in multiple restoration projects in Hawaiʻi with proven success (Oahu Army Natural Resources Program pers. comm.). Slash will be chipped on-site and spread around the fence perimeter to facilitate weed suppression on the fence skirt. The native plant species that will be out-planted after invasive weed removal (see table 1 below) were selected based on historical and current distribution of suitable native coastal plants, as well as species that will provide seabird and Nēnē habitat. The native plants are low-in-stature, thus making burrow excavation easier for the birds, while simultaneously being low-maintenance and providing forage for Nēnē .

Scientific Name	**Hawaiian or Common Name**
Heteropogon contortus	pili grass
Eragrostis variabilis	kawelu grass
Myoporum sandwicense	Naio
Osteomeles anthyllidifolia	ʻūlei
Pandanus tectorius	hala, pū hala
Euphorbia celastroides var. stokesii	\`akoko, koko, \`ekoko, kōkōmālei
Lipochaeta succulent	Nehe
Sida fallax	\`ilima
Sesuvium portulacastrum	ʻākulikuli
Vigna marina	Nanea
Scaevola taccada	naupaka kahakai, huahekili
Vitex rotundifolia	Pōhinahina
Sporobolus virginicus	ʻAkiʻaki grass

Table 3: List of native plants that will be outplanted at the Nihoku seabird translocation site.

The current distribution of HAPE is thought to be an artifact of range constriction as a result of predation and habitat destruction rather than a true preference- i.e. only the most inaccessible colonies are left. Hawaiian Petrel habitat preferences were described by Simons and Hodges (1998) on Maui as being sub-humid, subalpine dry habitat with <10% vegetation cover. The breeding habitat of extant HAPE populations currently being monitored on Kaua\`i at Upper Limahuli Preserve and Hono o Na Pali NAR are characterized by burrows or caves located on steep slopes within areas dominated by native vegetation such as ōhiʻa and Uluhe fern (KESRP unpublished data). Sites with vegetation cover are dominated by shrubby plant on Hawaiʻi Island. Fossil evidence indicates that HAPE were once one of the most abundant seabird species in the Hawaiian Islands with numerous colony sites being at low elevation (Olson and James 1982a, 1982b, Monitz 1997), so proposing to translocate them to a low elevation habitat would still be within their historical range.

In numerous seabird translocation projects undertaken on related Procellariform species in New Zealand over the last twenty years, the issue of actual vs. artifact habitat preference has been addressed by re-creating the physical condition of the burrows (length, depth, temperature, substrate and humidity) and canopy cover (open, shrubby, full canopy etc.) as much as possible at the sites where birds have been translocated, but not worrying extensively about the precise plant species composition. At many of the sites that were visited as a training exercise for this project, non-native understory grass species were left in place for easy maintenance, and the focus was on the larger shrub/canopy layer when undertaking restoration (if restoration was done at all). Therefore, we feel that the approach outlined in this plan of a partial restoration will adequately prepare the site for seabird translocations, and have the added benefit of improving the habitat for existing native bird species while reducing maintenance needs, such as mowing and weeding.

Artificial burrows will be installed in the center of the reserve, and surrounding habitat restored to mostly native dominant plant communities (figure 5) during the summer of 2015 in anticipation of a possible fall 2015 translocation. Artificial burrow design is described in more detail below.

Interactions and impacts with other species

Based on the species currently present in the project area, with the exception of Barn Owls and possibly Wedge-tailed Shearwaters (WTSH), no negative interactions are anticipated between HAPE and any other animal or plant in the fenced area site. The successful establishment of these seabirds on the site would likely increase soil fertility, with benefits for a wide range of species. However, the presence of Barn Owls at the site is a concern since they cannot be excluded from the area and are known seabird predators. During the translocation period and throughout the life of this project, Barn Owl control would need to be implemented to prevent any of the fledglings from being taken by Owls. Control during the recruitment period will be done on an as-needed basis.

While there are no WTSH nesting currently in the project area, they do nest nearby (closest colony is <250m, and one pair is immediately outside the fenced area). It is possible that once the habitat has been prepared and artificial burrows are installed, they may move into the area. While Wedge-tailed Shearwaters have been known to displace NESH from breeding burrows (USFWS unpub data; Raine and Banfield 2014) and potentially inflict harm on NESH adults, this has not been documented in HAPE, mainly because there are no coastal HAPE nesting areas. In the fossil record prior to human contact, the two species nested in similar habitats, and thus it is assumed that they are able to coexist successfully.

Source site selection

Surveys to locate potential donor colonies

In 2012, a total of 167 surveys were conducted at four potential HAPE colonies – Makaleha, Kahili/Kalaheo, North Fork Wailua and Koluahonu. The highest call rate was found at the North Fork Wailua Colony (an average of 217 calls/ hour), and the lowest at the Koluahonu Colony (56 calls/ hour). Three new burrows were located in the Kahili region, and one at the Kalaheo colony. Additionally, locations of high calling rates or potential ground calling were identified at all five sites.

In 2013, the focus shifted somewhat. As well as undertaking surveys at five low elevation sites with high risk of colony extirpation, three higher-elevation sites were also included. These higher elevation areas had known colonies of HAPE, had higher levels of activity when compared with the low elevation sites, and had active colony management. These additional sites were included in the surveys due to the low success of locating nests in the low elevation sites (due to the fact that there were very few birds left at these sites). As with 2012, KPNWR was also included in the surveys. A total of 165 surveys were conducted at nine colonies in 2013 - KPNWR, Makaleha, Kahili/Kalaheo, North Fork Wailua, Koluahonu, Sleeping Giant, Upper Limahuli Preserve and Hono o Na Pali North Bog. The highest call rate was found at one of the higher elevation sites, Upper Limahuli Preserve (an average of 363 calls/ hour), and the lowest at the Koluahonu Colony (79 calls/ hour). All these potential donor sites must be accessed by helicopter.

A third and final series of surveys were conducted in 2014. Due to the very low number of burrows located in colonies with a high risk of extirpation, surveys in 2014 focused on higher elevation sites with large concentrations of birds, namely three sites in the Hono o Na Pali NAR (Pihea, Pohakea and North Bog) and Upper Limahuli Preserve. A small number of surveys were also undertaken at North Fork Wailua and Kahili.

Potential effects of removal

To identify (or decide on) donor colonies for the project, a number of factors have been considered, including number of known burrows, estimated size of colony, immediate threats to colony and long-term sustainability, existing colony management actions, land ownership and access. The current sites that are considered to be suitable potential source colonies are all within the Hono o Na Pali Natural Area Reserve- Pohakea, North Bog and Pihea for reasons described below.

The proposed removal of up to a maximum 100 HAPE chicks from up to four colonies (with a minimum of 158 active nests) over a five year period (10-20 per year depending on the year) will likely have minimal impacts on the local, or species level population of HAPE. The largest colony (North Bog) has a minimum of 79 HAPE burrows and in 2014 produced a minimum of 27 chicks. If one considers the number of known HAPE burrows in North Bog and assumes all are active in the first year of translocation then the proposed total take of 10 nestlings in 2014 is a small proportion (12.7%) of total production at that site. However, under the proposed removal regime for the translocation project only 3-4 nestlings would be removed from each site – in which case 4 nestlings would represent 5.1% of total known burrows at this site. It should also be noted that new burrows are found each year (ie in 2014 a further 11 HAPE burrows were located at North Bog alone and therefore there are almost certainly many more birds breeding within the North Bog area (and indeed all proposed source colony sites) and thus the estimate proportion of chicks removed is likely much lower.

SITE	# HAPE burrows	# Active 2014	# Confirmed Breeding 2014	# Predated in 2014	# Fledged in 2014	FS (Fledged/ Confirmed) 2014
Upper Limahuli Preserve	23	17	13	1	8	61.54%
HNP : Pihea	46	39	30	5	23	76.67%
HNP : Pohakea	10	10	6	4	2	33.33%
HNP : North Bog	79	76	56	15	27	48.21%
	158	**142**	**105**	**25**	**60**	**54.94%**

Table 1: Potential HAPE source colony sites and associated reproductive outcomes.

Considering the small number of chicks taken out of any colony in a given year, coupled with the fact that we would use different burrows in different years (i.e. chicks would not be removed from the same burrow in consecutive years), it is unlikely that this will have a measurable impact on the local, or species level population of HAPE since the vast majority of the translocation chicks are expected to fledge. In other species, much higher proportions of nestlings are removed from the colonies for conservation purposes. In the critically endangered Cahow (*Pterodroma cahow*) and in the Taiko (*Pterodroma magentae*) 100% of the chicks produced for the species are removed each year to start a new colony (since both species are restricted to a single colony; Carlisle et al. 2012).

It is important to consider predation levels at current colonies. In areas where no predator control is occurring, predation levels of breeding seabirds and their chicks can be extremely high. For example, Jones (2000) found that New Zealand shearwater colonies would disappear within the next 20-40 years on the mainland of New Zealand without significant management actions to eliminate predation by introduced mammals. Chicks that would be removed and hand-reared at a translocation site would likely have higher survival than chicks from sites without predator control. Furthermore, monitoring of predation levels of nesting endangered seabirds in areas on Kaua`i where predator control is currently on-going has revealed that predation of chicks - in particular by feral cats, pigs and Black Rats - is still an issue (Raine and McFarland 2014a; Raine and McFarland 2014b). For example, at North Bog in Hono o Na Pali NARS, 25% of all monitored HAPE chicks were killed by rats in 2013 and 9.2% in 2014. Cats continue to predate upon both species at all sites every year, with cat predation events recorded in all three Hono o Na Pali sites in 2014. Therefore survival to fledgling of birds in these colonies is already reduced. Simons (1984) also estimated that only 27% of HAPE chicks survive to adulthood. With the above being the case, the removal of three or four chicks in a given year from several different colonies, regardless of whether predator control is occurring, is unlikely to cause any issues with the overall recruitment of source colonies since a portion of the translocation chicks would not have survived to fledge in the source colonies regardless.

Another concern is the potential desertion of breeding pairs from burrows where chicks have been removed for translocation purposes. This has not been a serious issue in previous projects. In a number of other translocation studies (Miskelley et al. 2009), it was found that adults return the following year despite the removal of their chick prior to fledging. There is also some suggestion in related species that breeding pairs whose chicks die (or in the case of translocation are removed) may have a higher survival rate as they are able to spend more time foraging for self-maintenance compared to pairs with an active chick (VanderWerf and Young 2011). In HAPE burrows currently monitored on Kaua`i, breeding pairs return in subsequent years after their chicks have been predated and successfully fledge young in the following year (KESRP unpub data).

The proposed translocation to Nihoku is also likely to be neutral from a genetic perspective since very few seabirds (or land birds) have distinct genetic structure of populations on the same island and the genetic structure of HAPE has been well studied (Welch *et al.* 2012). It is likely that many HAPE populations on Kaua`i were at one point continuous and are only now discrete as a result of habitat fragmentation and population declines (Olson and James 1982a and 1982b). Potential impacts of human visitation at source colonies that could be considered are damage to nesting habitat by repeat visits, disturbance resulting in temporary or permanent burrow desertion by adults (although this has never been recorded in areas currently monitored on Kaua`i at a frequency of up to eight visits per year), and the creation of trails to burrows that could be used by introduced predators. These potential impacts will be minimized by:

- Following existing trails whenever possible, and avoid creating new trails
- Concentrate only on areas where predator control is on-going, so that animals that may be attracted to the area will have reduced impacts
- Repairing all burrows damaged accidentally by trampling
- Minimizing the number of visits to each burrow and using burrow cameras to help assess viability of any given burrow for use as a source bird for translocation; and
- Using a team of two trained people on nestling collection trips to minimize disturbance levels.

Collection and removal of donor chicks

Age at translocation

Age of the chick at translocation is an important variable that needs to be optimized to allow chicks the longest time possible with their natural parents for species imprinting, transfer of gut flora, and expert parental care without losing the opportunity for the chicks to imprint on the translocation site and increase the probability that they will eventually recruit to the new site. In addition to thermoregulatory and nutritional benefits, it is possible that rearing by parent birds for the first month minimizes the chance that the chicks will imprint on humans, and allows transfer of parents' stomach oil (and possibly unknown species-specific micronutrients or antibodies) to the very young chicks.

Burrow-nesting seabird chicks are thought to gain cues from their surroundings during the emergence period shortly before fledging, and then use that information to imprint on their natal colony (‘locality imprinting). Chicks that have never ventured outside natal burrows can be successfully translocated to a new colony location. Success is optimized if chicks spend the greater proportion of the rearing period with parents before being moved.

For HAPE, age of first emergence is 15.8±0.94 days before fledging (n=22, min=7, max=29) (KESRP unpub data). This will likely be in late October to beginning of November based on on-going data collection at active burrows using Reconyx cameras. Trips will be made to source colonies in mid October, and chicks that appear to be in good health with the minimum mass and wing chord lengths described above will be selected.

Number of chicks in each translocation cohort, and number of cohorts

Factors important in choosing a cohort size for a chick translocation are genetics, rate of growth of the new colony, size of the source colony and the practical limitations of logistical capability and labor to care for the translocated chicks. Since these translocations involve only chicks of long-lived birds, it is unlikely that taking the proposed number of the chicks from the parent colony will affect the viability of that source population as it might have if one moved adult animals.

In New Zealand, for established translocation programs for burrowing species, a maximum of 100 chicks a year is considered appropriate to transfer for project totals of up to 500 birds over a five year period. The recommended number of chicks to transfer to a new site in the first year of a project is generally 50 chicks if the team is new to seabird translocations, and/or there are anticipated logistical issues to resolve at the release site (Gummer 2013). If the species has never been translocated before, a trial transfer of a small number of chicks (e.g., ≤10) may be appropriate to test artificial burrow design and hand-rearing methods. This is the approach that will be taken with HAPE.

Translocation projects ideally should span several years to increase the genetic heterogeneity of the translocated population, to accelerate the development of a natural population age structure at the new site, to increase the size of the translocation group within the staff capabilities for chick rearing, and to “spread the risk” associated with environmental stochasticity. Transferring a minimum of 200 chicks of burrow-nesting species over a 3−4 year period has now been tested on several projects in New Zealand. With increased confidence in techniques, it is now considered advantageous to move more than this to increase the pool of birds returning to the establishing colony site and the encounter rate of conspecifics, which is thought to be important in encouraging adults to settle there (Gummer 2013). Supplementary translocations in later years may also need to be considered. In year one, Helen Gummer, who has pioneered translocation in New Zealand, will be on-site for up to two weeks to personally advise the project and help ensure its success.

For the first year of HAPE translocations, 10 chicks will be removed and transferred to Nihoku following recommendations developed in New Zealand for new translocation projects. If fledging exceeds 70%, then 15 birds will be moved in year two. If fledging of year two birds meets or exceeds 80% then 20 birds will be moved in each of years 3-5 for a total of 100 birds. If fledging is below 50% in any given year, the project will be re-evaluated before proceeding. If fledging criteria are not met at any stage, numbers will not be increased until those numbers are met (see figure 6 below). The number of birds may also depend on whether additional suitable donor burrows can be located. The goal of this project is to transfer a minimum of 50 and up to 100 chicks over a five year period.

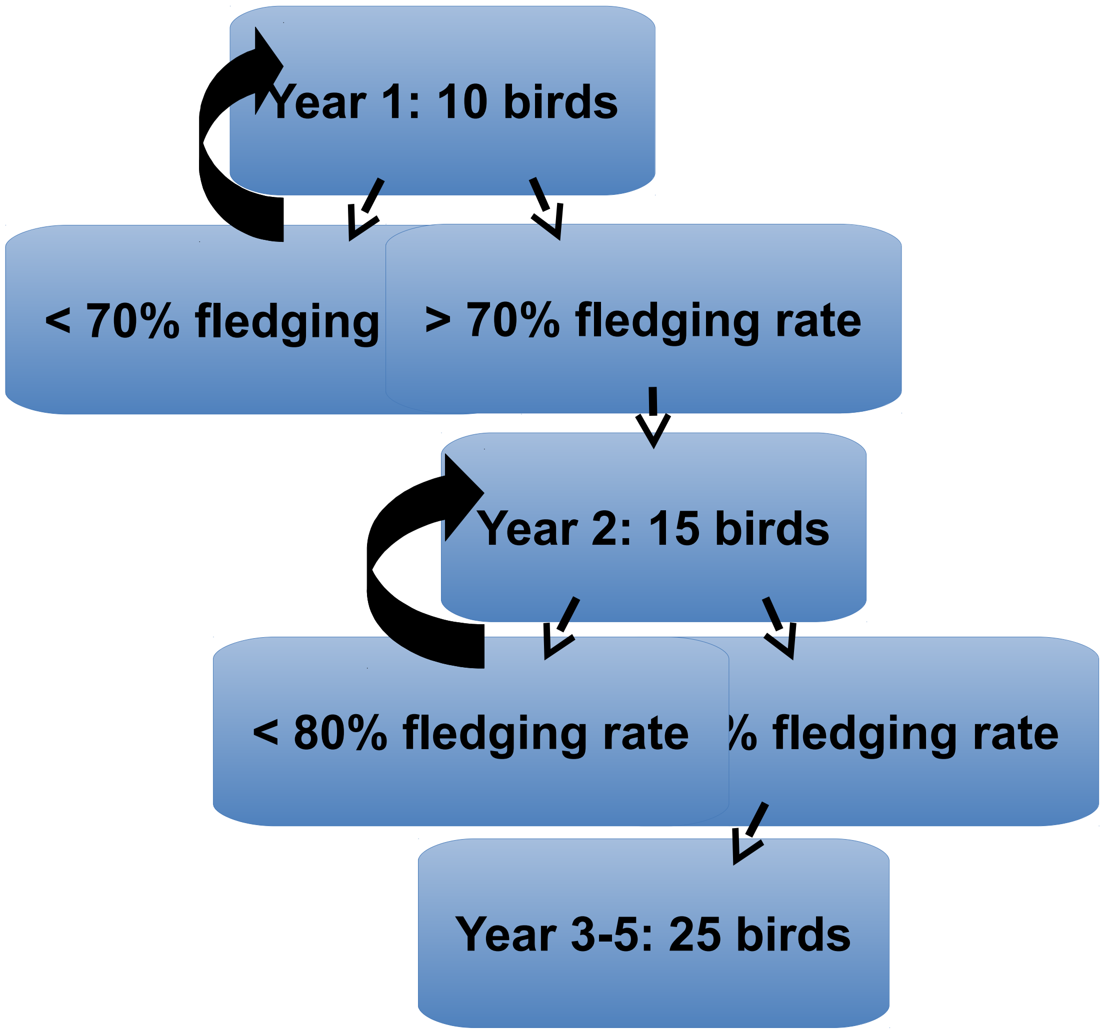

Figure 6: Proposed number of Hawaiian Petrel chicks to be translocated in each year with the minimum fledging criteria required to increase the number of birds removed in subsequent years.

Pre-capture monitoring

All potential source colonies are being monitored on a regular basis by the KESRP. Ten monitoring trips are carried out to these sites each year, and are undertaken once a month. Trips are made, based on the following schedule: (i) pre-arrival, to deploy cameras and song meters (late February), (ii) arrival of breeding HAPE (March), (iii) arrival of breeding NESH (April), (iv) incubation period (1 or 2 trips in June-July), (v) early chick-rearing period (1 or 2 trips in August-September), (vi) fledging or late chick-rearing period for Newell's Shearwater in October and (vii) fledging or late chick-rearing period for Hawaiian Petrel in November. This schedule is flexible depending on logistical considerations and project priorities.

During each visit, identified burrows are inspected to assess breeding status as per the standardized protocols outlined below. At all times, care is taken to minimize damage to surrounding vegetation and burrow structure through careful approach to and from the burrow site, with staff paying particular attention to vegetation and potential areas where the ground could collapse.

At each check, notes are made on any signs of activity within or around the nest. This includes (i) the presence of adult, egg or chick, (ii) scent, signs of digging or trampling, and/or (iii) presence of feathers, guano or egg shell. A note is also be made as to whether or not it was possible to see to the back of the burrow (e.g. was the burrow fully inspected, or was there a possibility that something was missed). Any signs of predation (such as a dead adult or chick in front of burrow or inside burrow), or the presence of scat/droppings/prints that indicate a predator has been in the vicinity of the nest, are also recorded.

A sub-set of burrows (30) are also monitored by cameras (Reconyx Hyperfire PC900). These cameras are mounted on poles located 3-10ft away from the burrow entrance and set on a rapid fire setting (motion sensor activated, with a trigger speed of 1.5sec). 8GB SD cards are used to record photographs, and these (along with the rechargeable batteries) are switched out on each visit to ensure continuous coverage over the season. If a burrow fails during the season or the chick successfully fledges, then the camera is moved to a new active burrow until the breeding season is over.

At the end of the season, a final status is assigned to each nest using the following categories:

- *Active, breeding confirmed* – breeding was confirmed as having been initiated during the season through the presence of an egg or chick. For this category, the outcome is noted as either:
    - *Success* – Nest successfully fledged a chick. As the site is remote and not visited regularly enough to actually see the chick fledge, a successful fledging is considered in the following scenario – A chick was confirmed in burrow up until typical fledging month (November/early December) and on the following check (i) the presence of small amounts of down outside the nest site indicate that the chick was active outside the burrow and subsequently fledged and/or (ii) there are no signs of predation or predator presence. Burrows with cameras provide information on exact fledging date and time.
    - *Failure* – Nest did not fledge a chick. The failure stage (egg or chick) and cause of failure (predation of chick or egg, abandonment, predation of breeding adult, etc.) is recorded where known. Burrows with cameras can provide information on predation events and predator visitations pertinent to nest failure.
    - *Outcome Unknown*- Breeding was confirmed at the site, however no subsequent visits were made, no visits were made late enough in the season to confirm fledging, or signs were inconclusive. Only a very small number of burrows fit into this category as every effort is made to assess the final status of all burrows.

- *Active, unknown* – the presence of an adult bird, or signs of an adult bird (guano, feathers, trampling, etc.) indicate that a bird was present during the breeding season but it was not possible to confirm whether breeding occurred and failed or breeding was never initiated. Either way no chick fledged. Situations like this arise in instances where (i) it was not possible to examine the back of the nesting chamber due to the structure of the burrow, (ii) an adult bird was confirmed in the burrow during the incubation period, but it was not possible to determine if it was incubating an egg, or (iii) the burrow is discovered late in the breeding season and, as it was not therefore monitored during the egg-laying period, it is not clear if breeding had been initiated (even if eggshell fragments are recorded, as they could have been from previous seasons).
- *Active, not productive* - the presence of an adult bird, or signs of an adult bird (guano, feathers, trampling, etc.) indicate that a bird was present during the breeding season but burrow inspections reveal that no breeding took place (i.e. no egg was ever laid).
- *Prospecting* – bird(s) recorded visiting nest, but signs are indicative that these are prospecting and not breeding birds. Examples would be new excavations within a previously inactive burrow, a single visit during the breeding season to a previously inactive burrow, a visit to a burrow where both adults had been confirmed killed the year before, or the preliminary excavation of a burrow-like structure combined with the confirmed presence of a seabird.
- *Inactive* – no sign that the burrow has been visited in that breeding season.

Selection of individual chicks to be moved
Chicks selected for translocation will be chicks that appear healthy and in good condition and are in burrows where they can be safely (and easily) removed. Chicks fledging in optimum condition have an improved chance of surviving and returning as adults. Ideally, chicks will meet species-specific criteria on the day of transfer (Gummer 2013), and thus, a combination of wing cord and mass measurements will be used to select chicks (see below for target measurements). Setting a transfer wing-length range ensures that only chicks of appropriate age are taken. Setting minimum transfer weights for different wing-length groupings ensures chicks can recover weight lost during transfer and while adapting to the hand-rearing diet, and still fledge in optimum condition. In addition, it is vital that chicks have not emerged at the source colony yet for even a single night to avoid imprinting on their natal site. Since all potential donor burrows will be monitored with cameras, it will be known if the chick has emerged.

Due to the limited number of burrows available from which to select chicks, every effort will be made to select chicks that meet the age (size) criteria set above. In the event that there are not enough burrows to choose from, we will select burrows where the chicks a) are reachable by hand from the burrow entrance and b) have not yet emerged from their burrow based on nest camera information/data.

Over multiple transfer years, efforts to maximize representation of different parents from different parts of the source colony will enhance genetic variety of the translocation group. This also prevents the same adult pair from being targeted for chick removal in subsequent years, potentially disrupting their pair bond by forcing them to ‘fail’ multiple times in their breeding attempts. Therefore, burrows that were used for a translocation in the previous breeding season will not be used in a second consecutive season.

Chick capture and transport
Minimizing the risks of overheating and injury in the carrying containers, and stress from unfamiliar stimuli, are major considerations for the chick capture and transport phase. The transfer box design used for most burrow-nesting petrel transfers in New Zealand is based on a standard pet (cat) box (Gummer 2013) and will be used for HAPE. There must be enough space and ventilation to avoid overheating issues, and to minimize wing and tail feather damage of the more advanced chicks. Boxes will also be heat-reflective, dark inside to reduce chick stress levels, and have flooring that provides grip and absorption of waste or regurgitant. Since only a small number of chicks will be taken, one box per chick will be used. Chicks will be removed by hand from the burrow, and placed into transfer boxes. Boxes will then be loaded into the cabin of the helicopter and secured to a seat for flight using rope. Once they have arrived at the Princeville airport (~15 minute flight from the natal colonies), they will be transferred into a vehicle and likewise secured into a passenger seat for transfer to the translocation site (~30 minute drive). It is expected that birds will be in their transfer boxes for 4 hours maximum and every effort will be made to ensure that transfer time is as short as possible. Upon arrival at Nihoku, each chick will be banded to help with individual identification.

Post-collection donor colony monitoring
Each year, all of the colonies being used as source colonies will be monitored to assess potential effects of the translocation of chicks on the future breeding efforts of donor burrows. If birds are transferred from areas already under management and monitoring regimes then all burrows will already be monitored ten times spanning the breeding season to assess whether the burrow is active, breeding has been initiated, whether a chick has hatched and whether a chick has fledged (see pre-collection monitoring for details). As all burrows are given a unique identification tag, the progress of each burrow in any given season is known. It will therefore be possible to assess whether burrows used as donor burrows in the previous season show any change in productivity in the following year. If a negative effect is noted, then the translocation protocols will be re-assessed.

Chick care at the new colony site

Artificial burrow design and burrow blockage procedures

Standard artificial burrow designs used in New Zealand for similar Procellariformes species are 5-sided wooden boxes (four sides plus a lid) with open bottoms and corrugated plastic PVC tubes for burrow entrances. A similar design will be used for HAPE, but with a lighter weight plastic that has been used for the tropical nesting Bermuda Cahow and Audubon's Shearwater in the Carribean (see figure 7).

Figure 7: Example of the artificial burrow design that will be used

The nest boxes that will be use are manufactured in 0.3 cm thick High Density Polyethylene (HDPE) and fabricated in a size for accommodating all burrow/cavity nesting seabirds in the weight range 250 – 600g (see attached specifications). HDPE is chemically inert and very durable and the thickness is strong enough to resist warping or physical damage from trampling, tree-fall and rock-fall in most circumstances, especially when buried in soil substrate. The burrows (pictured above) are square boxes measuring 50 x 50 cm and are 38 cm high. They have hinged lids for easy access and a modular tunnel component that can be cut to any length and with 225˚ angled sleeves to allow the tunnel to make turns (to keep out light). The opening of the tunnel is 15cm in diameter. Burrows will be dug into the ground, and lids will be drilled with holes in the side to allow for airflow, and sandbags will be placed on burrow lids to keep the sun from warming the burrows and burrow temperatures will be monitored with thermometers regularly to ensure they do not overheat. The burrow floor material will either be bare soil if adequate drainage exists, or will consist of a layer of gravel topped with straw to prevent flooding and mud accumulation. This determination will be made at the time of burrow placement and will depend on localized soil conditions; both bottom designs have been successfully used for closely related Procellariiform translocations.

In order to ensure that newly translocated chicks do not wander out of the burrow prematurely, entrances will blocked on both ends of the entrance tube. The interior entrance to the burrow chamber from the tube will be blocked with a square panel of metal mesh screening to allow airflow, and the exterior entrance will be blocked by placing a large rock (about the size of the tube opening) in front of it to reduce light penetration into the burrow. A double sided blocking procedure is done to ensure that chicks do not get trapped in the PVC tube if they attempt to leave the burrow are unable to turn around if just the exterior burrow entrance block is placed. The exterior entrance block is to prevent newly emerged chicks from adjacent burrows wandering into the burrow opening and similarly are unable to turn around when they reach the chamber mesh screening.

Burrow blocks will be removed on an individual basis depending on chick developmental stage and proximity to fledging. Criteria are as follows based on 90 day old chicks (~1 month prior to fledging) from Simons 1985 and Judge et al 2014:

- Wing length: ≥170 mm
- Weight: ≥500 g
- Down cover: Not exceeding 60% (looking down on chick from above)
- Wing growth rate: Slowed from up to 9 mm/day, down to <5 mm/day

Down cover should not be relied on as a sole guide to gate removal as it can be prematurely lost on the transfer day, or through handling, especially in wet weather. Down coverage is recorded by visually estimating the percentage of down left when looking down on the chick from above. Down-cover percentage is used as a cue to preventing premature blockade removal; chicks with ≥60% estimated cover are not allowed to emerge, especially if they are lighter in weight, as they are considered to be too far from fledging and may be compromised without further meals if they disappeared.

Blocking the entrances of burrows will also be undertaken prior to the HAPE breeding season to minimize the possibility that WTSH will take over the nesting sites. Burrows will be blocked once all birds have fledged and will remain blocked until the start of the HAPE breeding season at the beginning of April and will have cameras deployed on them to determine if WTSH are actively investigating the burrows.

Diet and feeding procedures

All meals will be prepared off-site either at the refuge offices, or a private residence with access to electricity and water. All meals will be prepared at room temperature and transported to the translocation site in a cooler each day and all clean-up will be done at the same location to maintain hygienic standards (outlined below).

<u>Recipe</u>

Previous projects in New Zealand have used 1 (106 g) tin Brunswick™ sardines (89%) in soy oil (10%) (including oil contents), one-third Mazuri™ Vita-zu bird tablet (vitamin supplement) coupled with 50 ml cold (boiled > 3 min) water. This diet is stable at room temperature (prior to preparation) and is easy to obtain and bring into the field. It also was the clear winner in a feeding trial conducted by Miskelley et al. (2009) of translocation projects in New Zealand.

However, based on the approximated nutritional content compared to that of the natural diets of HAPE the caloric levels are different.

The current formula used for HAPE being rehabilitated at facilities in Hawaii (including the SOS program and Hawai`i Wildlife Center) consists of half Capelin and half Lake Smelt (both fresh frozen), powdered Piscivore formula from Lafeber, Mazuri Vita-Zu and Centrum vitamins and enough water to pass through a rubber feeding tube (T. Anderson and J. Ellal, pers comm).

Table 4: Approximate nutritional content of natural and artificial HAPE diets (Simons 1985).

Diet	Calories per 100g	Protein (%)	Fat (%)	Carbohydrate (%)
Brunswick sardine diet	236	17.9	18.9	0
Capelin and Lake Smelt diet	137	16.8	7	0.25
HAPE Natural diet (50% squid; 50% flying fish)	92	18.5	1.2	1.5

<u>Preparing food:</u>
Mazuri tablets (or portions of tablets) will be crushed to as fine a powder as possible. The tablets do not dissolve, so crushing to a fine dust allows the vitamins to be equally distributed in the mixture. If making four tins of fish (700ml total volume), 200 ml cold (boiled > 3 mins) water will be placed in a blender with two tins of fish (chop fish up in tin) and blended until runny (at least 30 sec). A third tin of chopped fish (or equal mass of fresh fish) will then be added and blended until runny. Vitamin powder will then be added through hole in lid while blender running at low speed. The fourth tin of chopped fish will be added and blended until smooth. The mixture will be kept cold until immediately before feeding.

Food will be warmed immediately (<10 min) before feeding to prevent bacterial build up. Temperature will be tested on with a thermometer and will not exceed 33°C (cold mix e.g. <30°C may be rejected by chick; hot mix e.g. >35°C may damage chick's internal tissues). Food temperature will be monitored regularly (aiming for ~ 33ºC) and stirred with a spoon before drawing up food (the thick part of the mix can settle).

<u>Retrieving chicks from burrows:</u>
The methods outlined below are for a two person teams (a feeder permanently in the shed located by the artificial burrows and a handler/runner collecting, holding and returning chicks). Prior to starting feeding for the day, complete rounds of all occupied burrows to check on welfare of all birds will occur. Each burrow will be visited in numerical order (to ensure all are checked), and the overall welfare of the chick will be checked in addition to signs of regurgitation in burrow, or abnormal excrement, and for any signs of digging in blockaded burrows. Any missing chicks will be searched for, including in un-occupied artificial burrows, in the event that they wander into an adjacent burrow.

Chicks will be processed in the following order:

1. Extract from burrow

2. Check band
3. Weigh (to obtain pre-feed or base weight)
4. Measure wing length (right wing) if wing measuring day
5. Any other handling (e.g. physical examination, down coverage estimates)
6. Feed (recording amount delivered in ml; no post-feed weight required)
7. Return to burrow

When birds are removed, they will be placed in a carrying box. Carrier boxes will each be painted with a different color, to which a painted block of the same color corresponds. A block of the same color as its box will be placed atop the burrow when the chick belonging to that burrow is removed. After feeding, the chick is returned to its burrow and the block is removed to be used for the next feed. This helps to prevent confusion during feeding, and eliminated the carrier's need to remember which burrow their chick came from.

Figure 8: Example of colony transport box with colors to match burrows

Feeding chicks:
All feeding will be done in temporary 7' x 7' plastic shed on-site to shield chicks from inclement weather (e.g., rain, direct sun, wind). The shed will be pre-assembled plastic (such as item # 204721823 from www.homedepot.com), and have doors that can be closed to keep dirt out. It will be erected immediately before the translocation starts, and dismantled once the chicks fledge each year; all refuse from the project will be disposed of off-site. The handler will hold the chick firmly on a surface (with towel) with a loose hand grip—the chick must not be tightly gripped or it will not feed properly and the crop area in particular needs to be unrestricted. The feeder will hold open the bill (mainly grasping the upper bill), stretching the head and neck out (at approx. 30–40º angle from the horizontal). With other hand holding the syringe, the feeder inserts the crop tube to the back and side of the throat (to keep airway clear). Food delivery will be at least 30 seconds for a 40 g batch, with at least one rest approximately half way (c. 20 ml) through syringe load to check for any signs of meal rejection. Food delivery will stop at the pre-determined amount or earlier if signs of food coming back up throat. The bill will be immediately released as the crop tube is withdrawn, so that if there is any regurgitation the food can be projected clear of the plumage and risk of aspirating food is reduced.

Figure 9: Demonstration of proper feeding technique, and apparatus from a Fluttering Shearwater (*Puffinus gavia*) translocation project in New Zealand.

After feeding, the chick will be cleaned with a soft tissue so that there is no food on the bill or plumage. Soiling of the plumage with foreign materials can disrupt water-proofing and insulation. Particular attention will be paid to the base of the bill where food can build up and form a crust if not cleaned away. The amount of food actually taken by chick will be recorded. Any details regarding food delivery e.g. regurgitation, overflow, appears full, difficult feeder requiring plenty of breaks, resists food, good feed etc. will be recorded to help with the planning of subsequent meal sizes.

Chicks will be fed amounts according to the following table, after obtaining weights on the day after transfer. These amounts are based on translocation data from the related Fluttering Shearwater translocation, and while they are expected to be similar for HAPE, they may be changed on an as-needed basis. The food amounts below are comparable to known meal sizes for HAPE chicks in the wild (Simons 1985) despite HAPE being 33% larger in mass (424g) than Fluttering Shearwaters.

	Meal plans for chicks at particular weights / wing lengths on day after transfer		
Feeding day	<300 g / all wings	>300 g / <170 mm	>300 g / >170 mm wing
Day 1	30 mL	40 mL	40 mL

Day 2	30 mL	40 mL	50 mL
Day 3	40 mL	50 mL	60 mL
Day 4	40 mL	50 mL	70 mL
Day 5	50 mL	60 mL	70 mL
Day 6	50 mL	60 mL	70–80 mL
Day 7	60 mL	70 mL	Etc.
Day 8	60 mL	70 mL	
Day 9	70 mL	70–80 mL	
Day 10	70 mL	Etc.	
Day 11	70–80 mL		

Table 5: Recommended daily meal sizes for HAPE chicks hand-fed on Brunswick Sardines in soya oil.

Criteria are developed around weights taken on day after transfer rather than transfer day, because chicks can lose weight in the 24 hours after collection from burrows at the source colony. Food volumes will be increased more rapidly for more advanced chicks (wings >270 mm) as they will have a shorter period of time to make the appropriate weight gains before fledging. Meal sizes in Fluttering Shearwaters peak around 70–80 ml and are then gradually reduced (usually 10 ml increments) when:

- Chicks show signs of overflowing during feeding; and/or,
- Chicks are not emerging when expected, especially if wing growth had slowed down or ceased and down coverage had reduced; and/or,
- Chicks appear to be gaining weight during the emergence period.

If chicks are allowed to gain too much weight, e.g. reach weights >600 g, then they are likely to take longer to emerge and longer to depart, because in most cases chicks fledge at 434 g. A cap of 600 g is suggested before they lose weight prior to departure.

Sterilization procedures

Maintaining sterile conditions for husbandry tasks will be crucial to preventing infections in the transferred chicks. Food storage, preparation and cleaning will all occur at the refuge where there will be access to electricity, a sink and refrigerator; meals will be carried in a cooler to Nihoku immediately prior to feeding. Microshields™ chlorhexidine (5%) will be used for all disinfecting tasks. All feeding and food prep instruments and tools will be disinfected using chlorhexidine and rinsed using boiled water prior to commencing feeding and each individual bird will have its own sterile syringe and stomach tube each day to avoid cross-contamination between feedings. All work surfaces will be wiped down with kitchen towels and disinfectant spray (or leftover sterilizing solution), or with antibacterial surface wipes both before and after feedings. Any weigh boxes that have been used will be washed and rinsed, and set out to dry.

Chick health and morphometric monitoring

As well as the physical health check made prior to transfer, a full physical examination will be given when chicks arrive at the release site, and at any point thereafter where there is unexpected and/or unusual chick behavior or posture. The Short-tailed Albatross translocation team collected blood samples to compare 9 different blood chemistry parameters with the same ones in naturally reared chicks (Deguchi *et al.* 2012a,b) and to characterize the effects of transmitter attachment and handling on hand-reared chicks. These measures provided insight into health status and body condition of the artificially reared birds indicating better nutritional status in hand-reared birds than those raised by wild parents but evidence of possible muscle damage or capture myopathy in birds handled for transmitter attachment. At a minimum, HAPE chicks to be transferred will have baseline blood panels and disease screening conducted on the day of transfer, and then again close to fledging.

All efforts will be made to minimize incidences of regurgitation, and to handle chicks in such a way that regurgitant can be projected away from the body. Regurgitation can have serious consequences, including soiling of plumage spoiling water-proofing and insulation; possible asphyxiation; and, aspiration of food particles leading to respiratory illness. Burrows will be carefully inspected for signs of regurgitation, especially while chicks adjust to a new diet and feeding regime, and to ensure chicks are passing normal feces and urates.

Other serious health issues that staff will be aware of include: ventriculitis/ proventriculitis injury (caused by gut stasis or food contamination); aspiration of food (caused by regurgitation or poor feeding technique); and dehydration and heat stress. Appropriate first-aid treatment will be available if chicks injure themselves during the emergence period (see veterinary care and necropsy section).

Aside from basic health checks, one of the most important measurements that will be used in decision-making will be chick mass. Chicks will be weighed by placing them in a tared weigh box onto a table-top scale. The box will be cleaned between each chick measurement. Weight will be recorded in grams.

Wing measurements may be made every 3–5 days for younger chicks to assist with planning meals and gate removal. Wing measurements will be taken at the following intervals and done less frequently than weight since a higher chance of injury is associated with wing measurements:

- Day of transfer in natal colony
- Soon after transfer on translocation site
- When wings are predicted to be around 270 mm in length (based on a daily growth rate of up to 3 mm/day);
- 3–5 days later to determine the wing growth rate once chicks had reached or exceeded 275 mm (to help schedule blockade removal).
- On alternate days once blockades are removed to record departure wing lengths. Wing measurements can stop being measured once three measurements read the same (i.e. wing has stopped growing).
- Younger chicks can also be measured at opportunistic intervals, to monitor progress,

To measure wing length, birds will be kept in bags (to keep calm), and the right wing will be removed to measure—straightened and flattened to record maximum wing chord. Whenever possible, this measurement will be done by the same person to reduce inter-observer bias. If the potential exists for two observers to take measurements, they will be calibrated against each other to apply any needed corrections to the data.

Fledging criteria
Chicks of New Zealand species are not allowed to exit burrows before they have reached the minimum known first emergence wing-length for the species (emerging species), or are just short of the minimum known fledging wing-length (species fledging on the first night outside the burrow). Burrow blockade removal strategies have been developed to ensure that chicks do not leave the burrow prematurely and still have a good chance of fledging, even if at the lower end of the target fledging weight range for the species. Secondary criteria are species-specific and include weight, wing-growth rates and down coverage (Gummer 2013).

These strategies are necessary since it can be difficult to find chicks that have left their burrows. Lighter chicks that need to be fed daily are at the greatest risk if they can no longer receive meals, and some species are more prone to disappearing than others (e.g. Fluttering shearwaters; Gummer and Adams 2010). For NESH and HAPE, fledging criteria will be a combination of the measurements described below, a slowing of wing growth and reduced down.

Veterinary needs and necropsy protocols
Veterinary care will be provided locally by Dr. Woltman, DVM at Kauai Veterinary Clinic and all efforts will be made to stabilize chicks in the field so that they can remain at the translocation site. In the event that a chick cannot be stabilized in the field, it will be sent to the Save our Shearwaters facility at the Kauai Humane Society in Lihue for intensive care. Any chicks that expire during the process will be sent to Dr. Theirry Work at USGS for a full necropsy to determine the cause of death.

Translocation assessment

Measuring success

Establishment or restoration of colonies of Procellariiforms is a long-term commitment and markers of success will be incremental. Milestones that can be quantified include:

- Proportion of chicks that survive capture and transfer to new site
- Proportion of chicks that fledge from the colony
- Body condition of fledged chicks
- Proportion of translocated chicks that return to the new colony from which they fledged
- Number of prospecting birds fledged from other colonies that visit the translocation site.
- Number of those birds fledged from other sites that recruit to the new colony.
- Reproductive performance (hatching success, fledging success) of birds breeding in the new colony.
- Natural recruitment of chicks raised completely in the new colony
- Annual population growth within new colony

Most projects involving transfers of burrow nesting species in New Zealand have employed most, if not all, of the methods described above to monitor their success.

Monitoring success at Nihoku

Success at Nihoku will be monitored at various stages of the project. Items 1-3 from table 6 below will be measured in each year during the translocation itself. Items 4-8 will be measured over time- starting 3-5 years after the first translocation cohort fledges (i.e. after sufficient time has passed for birds to return to the site as adults). If birds are identified during these checks, the burrows will be regularly monitored through the duration of the breeding season. It is hoped that by year five, there will be at least one active breeding pair at the site.

Table 6: Metrics of success and targets that will be used to determine translocation outcomes

	Success Metric	**Nihoku Target**
1	% chicks that survive capture and transfer to new site	90% year one; 100% afterwards
2	Body condition of fledged chicks	Wing and mass measurements ≥ wild chicks
3	% chicks that fledge from the new colony	70% year one; 80% afterwards
4	% translocated chicks that return to the new colony	≥ 27% (rate of survival in wild colonies)
5	# birds fledged from other colonies that visit the translocation site	>0 (i.e. any visitors considered successful)
6	# birds fledged from other sites that recruit to the new colony	>0 (i.e. any new recruits considered successful)
7	Reproductive performance of birds breeding in the new colony.	Hatching and fledging rates ≥ wild colonies (39-61%; Simons 1985)
8	Natural recruitment of chicks raised completely in the new colony	≥ 27% (rate of survival in unprotected colonies) and by year 10

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Appendix

1. Equipment list
2. Summary of burrow searching efforts

APPENDIX 1: EQUIPMENT LIST

Source colony (chick selection, collection and transfer)

ITEM	#	COMMENTS
Flagging tape 3 colours	2 rolls each	For marking burrows of suitable chicks
Holding bags	20	Strong cloth bags, ideally dark colour to keep birds calm. Soiled bags are washed on a daily basis.
Wing rule (300 mm)	2	End stopped
Pesola scales 600g	2	Allow for bag weight
Banding kit plus X bands	2	X-bands (at least 200), pliers, circlips
Pet-carry boxes (with divisions)	10	White corflute boxes for up to 20 chicks.
Brown packing tape (wide)	2 rolls	Stick on top of boxes and write on in vivid marker – can then be removed so boxes are not permanently marked
Permanent marker pens	2	
Waterproof notebooks	2	
First aid kit (for birds)	1	
Newspaper	Lots	To line transfer boxes,
Anti-bacterial handwash		For cleaning hands prior to eating
First aid kit (for people)	1	
Tarpaulins and poles		To create a shade house for the birds awaiting transport
Spray bottle	2	To spray plumage for cooling if overheating occurs

Artificial burrow supplies

ITEM	#	COMMENTS

Artificial burrows (numbered)	100	
Internal mesh blockades	100	Bill-friendly design required; plastic to prevent bill abrasion and so that bills can't bet stuck.
Firm external blockades, e.g. rocks on island	1 per burrow	To block in chicks for appropriate number of nights following transfer
Fresh, dry grass reserve or leaf litter	Lots!	To be collected and dried well before the transfer day.

Morphometric supplies

ITEM	#	COMMENTS
Tool boxes	4	For carrying birds from burrows to shed (or transfer boxes used if preferred)
Newspaper	Lots	To line carry buckets or boxes
Holding bags	20	Strong cloth bags, ideally dark colour to keep birds calm. Soiled bags are washed on a daily basis.
Wing rule (300 mm)	1	Full stopped end
Digital table-top scales for shed	2	For daily weighing
Lithium cell batteries	4	For table-top scales. 1 battery lasted the month in 2012
Bird weigh boxes	2	To weight birds in bags on table-top scales
Pesola scales 600g or 800 g depending on bag weight.	2	Allow for bag weight (e.g. pillow cases weigh up to 100 g; home-made bags may be heavier). Ideally need a third back-up set.
Bulldog clip	2	To attach to scales for better grip of holding bags
Banding kit (with circlips)	1	To remove/replace bands if required; band new immigrants.
Washing line and clothes pegs	1 + lots	To hang up soiled holding bags and towels if needed

Food supplies

The following items are based on a canned sardine in soy oil diet. The list will need amending if any alterations, such as the use of fish oil, are made.

ITEM	QUANTITY	COMMENTS
Brunswick sardines *in soy oil* (106 g tins)	TBD	Ring-pull tins only. Diet recipe is 1 can sardines to 50 ml fresh water. 1 tin will feed approx. 2 chicks with 70 g meal size.
Mazuri Vita-zu seabird tablets	TBD	
Hartmann's Solution	375 mL	For hydrating birds on the transfer day (30 ml/bird plus some waste in hygiene process)

Food preparation and feeding supplies

ITEM	QUANTITY	COMMENTS
Kettle (large)	1	To boil water for > 3 mins if from remote source. Heat water for flasks
Blenders (SuNote:eam Pro–800 W)	1	Do not exceed 4 tins with 200 ml water as motor may burn out. Blades need to be removed for daily cleaning. Sharpen blades before storage.
Extension cable	1	For generator to blender
Small kitchen knife	1	Chopping sardines in tin
Measuring jug	1	Must be able to read to 10 ml (for water)
Plastic spatula (narrow preferable, not rubber)	1	To scrape blended fish from blender
Plastic spatulas or long spoons	2	To stir new food during warming
Plastic 1 liter pots (with lids)	2	Storing blended food (must be able to fit in hot-water bath)
50 ml Plexi-vet syringes	2	Easy to clean plexi-glass and should last a long time if looked after
Crop-feeding tubes (6.3 mm x 120 mm Teflon)	2	HG can make at $10/tube
Castor oil	1 small bottle	Lubricating syringes
Clean thermos flasks (2 liter)	2	Carrying boiled water to site for use in hot-water bath etc.
Yogurt-makers	1	Warming food prior to feeding
Small coolers	2	Keeping food cool, or warming food prior to feeding
Rectangular plastic	2	Rinse baths for crop tubes

boxes		
Clean plastic bottles (3 liter)	2	Carrying fresh/clean water (boiled > 3 mins) to feeding site
Plastic funnel	1	To fill flasks and bottles
10 liter bucket	1	Carrying gear to feed site. Doubles up as 'slops' bucket
20 liter bucket	1	Carrying gear to feed site. Doubles up as tissue bin
Medium-sized cooler	1	In hot weather, pots of food need to be kept cool for use later in the day.
Ice Packs	4	See above. Also used to keep dead chicks cool if needed
20 liter water container (with tap)	1	Storing fresh (non-boiled) water for cleaning, hand-washing etc.
Small hand towels	10	To rest birds on surface during feeding – t-towel size.
Soft tissues	10 boxes	For hygiene regime between chicks (not Budget or Pams brand as difficult to separate!)
Big container, e.g. fish bin	2	To store gear in at feeding shed.

Hygiene supplies

ITEM	#	COMMENTS
Dettol anti-bacterial flowing soap	2 (+ refill)	Cleaning hands before food prep., and one for use at colony site during feeding
Anti-bacterial hand-wipes	1 large	Cleaning hands during feeding events
Microshields chlorhexidine sol. (5% dilute)	1 liter	For short-term sterilization of feeding equipment between chicks. Usually has expiration date
Small measuring jug	1	For measuring chlorhexidine. Different to that used in food prep.
Bottle with lid	1	For holding freshly made chlorhexidine solution
Tall jars (e.g. 100ml caper jar)	2	For sterilizing solution (tubes stand upright, solution covers entire length). Economic use of chlorhexidine; larger jar can be used if antibacterial sol. Used
Old ice-cream tubs to stabilise jars	1	
Milton antibacterial tablets (1 tab/2 L water)	2 packets	Min soak time: check packet (different time for different brands)
15 liter bucket or similar	1	Antibacterial solution
Rubber gloves	Lots	Volunteers (for dishes)
Dish-washing liquid	1 L	Biodegradable type. Washing oily equipment daily
New washing-up	2	Washing equipment daily – need one for bird dishes and

brush		one for oily fish cans
Bottle brush	1	Washing sterilizing jars
Thick sponge wipes	1-2	Roll up to wash syringe barrels without scratching
Pipe-cleaners	Few packets	From Spotlight Stores craft section. For cleaning inside crop tubes.
Dishwash tub	2	For laundry sink – to save hot water amounts
Drying rack/basket for dishes	3	For laundry bench
Napisan (antibacterial) sanitiser (powder)	1	Soaking holding bags daily.
Kitchen towels	4 rolls	Handy at the feeding site for spillages, and cleaning out pipes/tunnels
Small disposable bin bags	1 roll	For daily load of fishy clean-up tissues! To fit in a 20 l bucket. (Preferably use recycled shopping bags)
Trigene	1 small bottle	For cleaning transfer boxes etc.

Chick health

The following list includes a precautionary first-aid kit, but does not contain drugs (such as Baycox) that would be prescribed and supplied by vets.

ITEM	#	COMMENTS
Spray bottle	1	To spray plumage if needing to stimulate preening
1 mL disposable syringes	As required	Easiest way to administer drug on an individual basis
Small ziplock bags	40	For faecal collections of 30 birds (plus spares)
Betadine gel	1	For open wounds.
Bandage (flexi-cohesive)	1 roll	Type that stretches and sticks to itself; for strained wings etc. following transport.
Saline	10 ml lots	To flush out eyes or wounds if required
Small sharp scissors	1	
List of vet contacts	1	Current phone nos./email address, including Wellington Zoo

Chick mortality

ITEM	#	COMMENTS
Plastic zip-lock bags	20+	A4 size; sending dead chicks, samples etc.

Plastic disposable gloves	20+	For handling dead birds, faeces etc
Polystyrene chilly-boxes (c. 300 x 200 mm)	3	For sending dead chicks with ice-pack off island for post mortem
Ice-packs (chilly slicks)	See food preparatio n	For sending dead chicks off island for post mortem (2 per box as boxes are quite large). These slicks are additional to those needed to keep food cool.
Wildlife health submission form	Several	To include with dead chicks sent for post mortem. Obtainable from DOC; document number OLDDM-724628
Printed address labels to Massey University	Several	For fast labelling of chilly bins containing corpses

Record keeping

ITEM	#	COMMENTS
Water-proof notebooks	2	Minimum of two required for roll-calls.
Data recording sheets	1 per chick	These may be more efficient in the shed than waterproof notebooks
Special notes sheets	Several	For adding extra notes on health issues etc.
Clipboards or folders	2	1 per team for new-style data sheets in shed
Band/burrow list (printed after transfer)	2	In band order, to locate home burrows of wandering birds
Laptop and USB flash drive (backing up)	1	Require replacement if contractor takes one away from island